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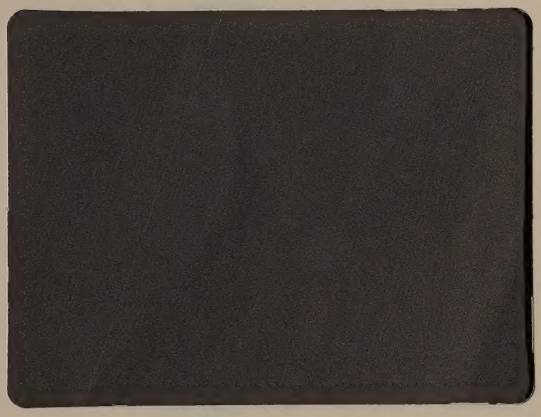

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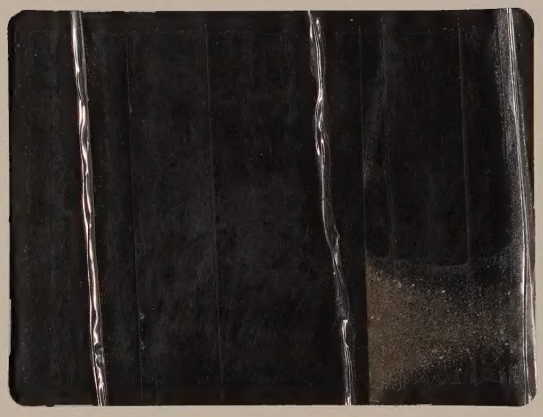

MODEL

DMA - 48/X

SOLID STATE POWER AMPLIFIER

INSTRUCTION MANUAL

M706722A Serial No.11
and up

0789

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Notwithstanding the provisions of the Warranty stated above, Permanent Magnet Shakers are warranted for a period of 90 days from date of shipment, and all Warranty repairs will be performed at LING's factory.

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LING DIGITAL AMPLIFIER
DMA-48/X SERIES

[ For the first time user of LING Digital Amplifiers or related high power electrical equipment, please read through this entire manual to assure a proper installation and safe, knowledgable operation. ]

## SECTION 1
## INTRODUCTION

### 1.1 DESCRIPTION

The LING D.M.A. product line is a series of efficient, air cooled, modular high power solid state amplifiers designed for continuous operation in vibration testing when used with appropriate shake tables and instrumentation. D M A means Digitally Modulated Amplifier ( Class D ) and consists of three (3) major sections:

- A POWER SUPPLY section for FIELD, ARMATURE and CONTROL
- A CONTROL section which contains the MODULATOR, LOGIC and monitoring of the protective interlocks.
- A variable number of POWER MODULES of 5 kVA each.

The POWER MODULES convert power from the ARMATURE POWER SUPPLY section, under control of the MODULATOR, into a variable amplitude and frequency drive for the shaker armature. This manual covers the DMA-48/X series of amplifiers. Each power cabinet in this frame size contains a power supply large enough for up to 12 output POWER MODULES at 5 kVA each. The DMA-48 mainframe is also able to accept a maximum of 66 inches (169cm) of instrumentation in the optional second system cabinet (less if an optional matching transformer is also housed here). The amplifier may run from a wide selection of input line voltages and does not require any special operating environment or support equipment.

The DMA-48/X family of amplifiers would be used in a typical system with an appropriately matched shaker and instrumentation system. The instrumentation may include signal generation ( either sine or random ) equipment such as:

- LING model DCS-7000SR ( sine or random spectrum )
- LING model SCO-1000 ( swept sine signals )

Additional support equipment may include protection, convienience and monitoring instruments such as:

- LING Model AGM-4000 ( quad charge amplifiers )
- LING Model TAP-1000 ( test article protector )
- LING Model VM-100 ( vibration monitor )
- LING Model VS-100 ( vibration servo )
- LING Model MXA-100 ( multiplexer/averager )
- LING Model MLP-102 ( multilevel programmer )
- LING Model DDI-100 ( digital displacement indicator )

Feedback accelerometers are necessary to close the loop from the test payload to the servo-ing unit, signal generator and amplifier. Some instruments include the necessary accelerometer charge amplifier. Additional charge amplifiers may be added to the equipment complement to monitor various payload points.

Refer to the system interconnect documentation and instrumentation manuals for more detailed information on instrumentation and their interconnection before powering up the system.

Field service assistance is available for customers with unique requirements.

## 1.2 Terminology

For the purposes of this manual, the following terms may be used interchangeably.

POWER MODULE, OUTPUT MODULE, POWER SWITCH or SWITCH MODULE all refer to assembly #713150, one of the basic amplifier building blocks; a minimum of one (1) is required in every power cabinet.

LOGIC MODULE, MODULATOR or CONTROL MODULE all refer to assembly # 713108. One (1) is required in every system.

The POWER MODULES are kVA rated, 5 kVA for each POWER MODULE. The POWER SUPPLY section is kW rated. Kilowatts (kW) is real power and kilo-Volt-Amps (kVA) is apparent power. The relationship is:

$$kW = kVA * \text{power factor (p.f.)}$$

The POWER MODULES can supply real or apparent power.

Abbreviations: CW = clockwise, CCW = counter clockwise
GND = ground, FET = field effect transistor
RMS = root mean square
RFI = radio frequency interference
FCC = Federal Communications Commission

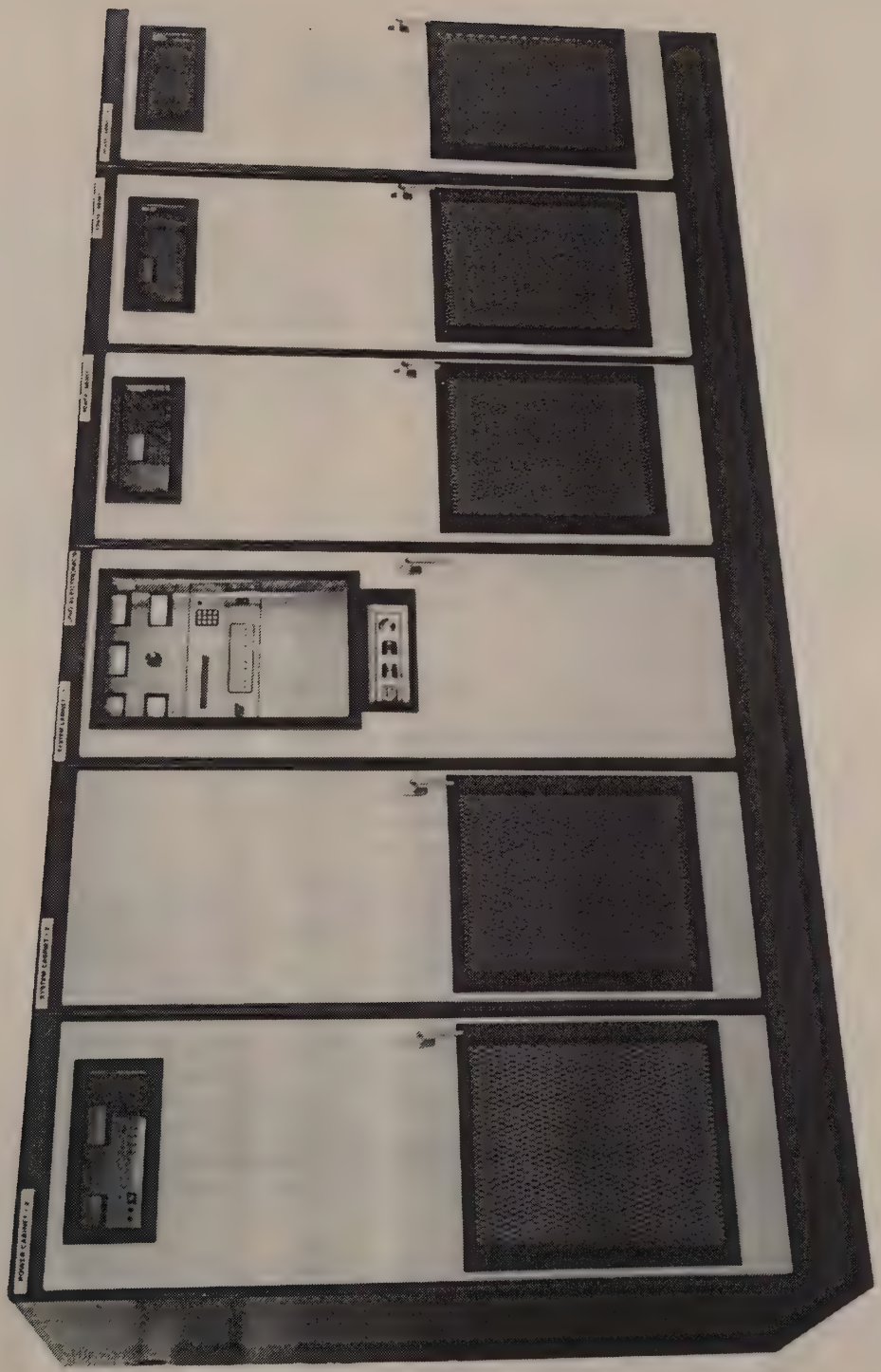

Figure 1-1
DMAX SERIES AIR-COOLED AMPLIFIER
48-Module Configuration, 240 kVA

Figure 1-1

DMA-48/X SOLID STATE POWER AMPLIFIER

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# SECTION 2
# INSTALLATION

## 2.1 Receiving Inspection

Match each item of the shipment with line items of the shipping documents. Inspect all items of the shipment for apparent external damage before accepting delivery. Notify the shipping agent and obtain a signed acknowledgement of any apparent damage before accepting the shipment. Do not sign a waiver of concealed damage until all units have been unpacked and inspected.

## 2.2 Unpacking

Remove any external tie-downs and wrapping material. Leave any internal shipping braces in place until the amplifier is on final location at its installation site.

### 2.2.1 Moving and Transporting

All moving should be done with the cabinets in their normal upright position. A system consists of a variable number of cabinets: the minimum system is one control cabinet (System Cabinet #1) and one power cabinet, the maximum system would have four (4) power cabinets and two system cabinets (System Cabinet #2 for options). Each cabinet is mechanically independant and may be shipped separately, to be bolted together at the final assembly site. Consult the LING factory if it is necessary to use any unusual procedures to get the amplifier sections into installation position. The sections may be moved with a fork lift, pallet jack or overhead crane. Lift from the base or use the lifting eyes provided, using common sense rigging techniques. The unit is not top heavy and, depending upon the configuration ordered and options, will weigh 1200 to 1500 lbs (545 to 680 kg).

### 2.2.2 Special Equipment and Situations

Some, more fragile, instruments and options will be shipped separately. Do not install any separately shipped equipment until after the amplifier is on final location.

If the amplifier has been specially packaged at your request or wrapped for tropical or marine shipment, leave these special wrappings on as long as possible.

## 2.3 Location Considerations

Locate your amplifier/instrumentation system in the most efficient manner for greatest production throughput. All front panel controls should be easily accessible and visible from the normal operator(s) station and still allow adequate working room around the vibration equipment to perform fixturing and testing.

Areas of high DUST, HEAT ( over 40°C ) or HUMIDITY should be avoided since the amplifier and instrumentation are air cooled and these type environments will only increase maintenance requirements.

### 2.3.1 Ventilation/Thermal Considerations

The transformer and power supply are both air cooled by convection and forced air. Therefore,

> **CAUTION**
>
> DO NOT BLOCK THE AIR FLOW INTAKE AT THE LOWER FRONT OF EACH CABINET. DO NOT BLOCK THE FAN AIR EXIT AT THE UPPER REAR OF EACH CABINET.

Impact on any air conditioning system will be 2750 BTU/hr/module (.806Kw) at full output. Effects of a complete system varies with shaker model and the specific shaker cooling unit.

Each amplifier POWER CABINET functions as a sub-amplifier and is rated up to 60 kVA with 12 OUTPUT modules. The power supply section is kW rated at 50 kW; the assumed average power factor is therefore 0.83. A thermal problem may exist if extended sine operation is demanded in the 200-500 Hz region. If sine dwells in the range of 1 hour or more are anticipated, the amplifier must be de-rated to 50 kVA per POWER CABINET.

### 2.3.2 National Electrical Code ( U.S.A.)

The electrical code requires grounding of all cabinet and shaker frames for safety. Refer to LING installation drawing #712800 for required ground conductor sizes. Additionally, for greatest noise suppression, a solid earth ground rod recommended within 6 inches (152mm) of the cabinet. Similarly, the amplifier should not be operated with any of its doors panels or covers removed.

WARNING

*** LETHAL VOLTAGES EXIST IN EACH CABINET ***

The Code requires a WORKING CLEARANCE of 42" (1.07m) to any live components when performing maintenance or troubleshooting on the amplifier with panels removed. The amplifier must be installed in complete compliance with article 110-16 of the National Electrical Code.

All GROUND wires are to be GREEN or GREEN with YELLOW stripe. This color can be used for no other purpose.

### 2.3.3 Cables - Routing

Route the FIELD, ARMATURE and INTERLOCK umbilical cables in the most direct and protected manner between the amplifier and shaker station. Some form of protection is preferred such as a cable tray, wiring trough or gutter. The high power ac cable to the shaker armature is not shielded; therefore, avoid running low level or unshielded signal or data cables in close proximity to its magnetic field.

## 2.4 Connections

Insure that all connections will be made in the most workman-like manner, marked and checked for tightness.

### 2.4.1 Line Input Power Installation

The amplifier was tested and shipped from LING with the input power configuration as requested on your order. If it has now become necessary to use a different input voltage, you may now have to change the input circuit breaker and primary wiring to the amplifier's power transformer.

NOTE

OBTAIN THE SERVICES OF A QUALIFIED ELECTRICIAN AT THIS TIME TO INSTALL THE PRIMARY POWER COMPLIANT WITH LOCAL CODES AND TO VERIFY YOUR AVAILABLE INPUT VOLTAGE.

Instruct your electrician to terminate the input power line on the main contactor. This is located behind the rear door of SYSTEM CABINET #1, on the upper chassis next to the field contactor.

Do not rely on the conduit system for grounding. Install a dedicated ground wire as indicated on the supplied LING installation drawing.

### 2.4.2 Cables - FIELD, ARMATURE and INTERLOCK Installation

The FIELD, ARMATURE and INTERLOCK cables are pre-made in standard 20 foot (6m) lengths, marked and prepared for connection to their respective terminal blocks on the amplifier end. All user interconnects are accessible in the rear of system cabinet #1. A cable exit cutout is provided in the lower corner of this cover.

REFER TO FIGURE 2-1 FOR THE FOLLOWING SECTION.

Connect ALL red "H" leads to the "H" terminal block or buss bar in the amplifier. Similarly, connect ALL black "J" wires to the amplifier "J" terminal block or buss buss bar.

Similarly, attach the slightly smaller shaker "N" ground lead of the ARMATURE cable to the chassis ground stud near the "H" & "J" connection blocks. The field terminal blocks are in the same general area, marked "E" & "F". Connect the field cables as marked ( E is + and F is -).

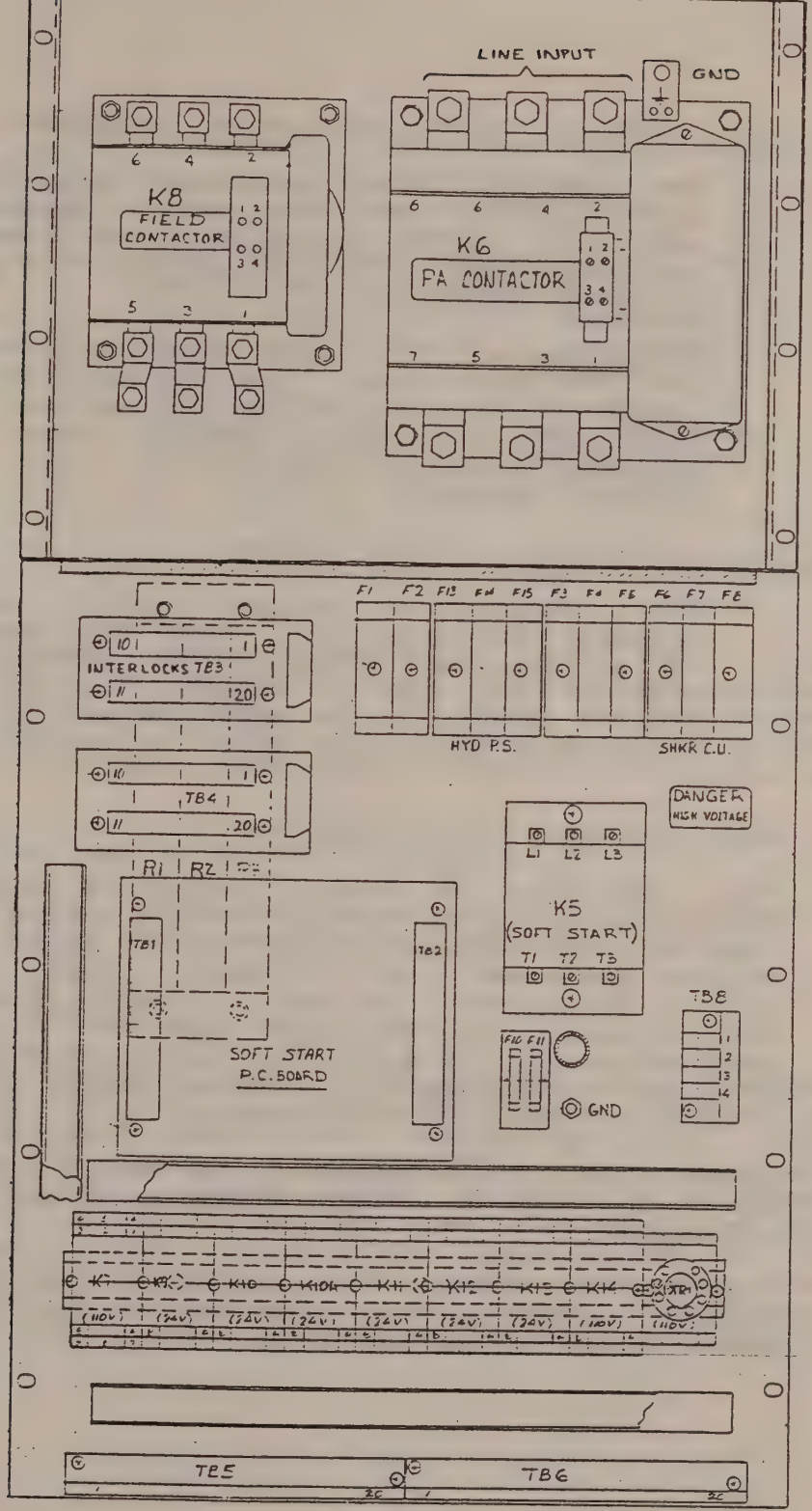


Figure 2-1

CABLE TERMINATION POINTS

2.4.2 Cables - Field, Armature and Interlocks ( cont.)

The required standard protection interlocks are shaker overtemperature and overtravel, shaker cooling unit and field. Connect the wires of the standard interlock cable as marked to TB3, TB4 and TB5 on the AC Power panel in system cabinet #1.

Interlocks may be either contact closures or equivalent gates or transistors. Each interlock may be selectively enabled or disabled by a switch bank on the LOGIC/MODULATOR circuit board. Refer to the Turn on Checkout Procedure (Section 2.6) for setting of these internal switches.

2.4.3 Grounding, Armature Output

The amplifier's armature output terminal "J" is normally referenced to ground for system stability. It is important to connect the grounded side of the armature to the "J" terminal, not the "H". Grounding the "J" terminal at the amplifier and the "H" lead at the shaker will effectively short the amplifier output.

## 2.5 Radio Frequency Interference (R.F.I.)

This amplifier is crystal controlled and uses digital techniques to sample and convert the input analog waveform into a pulse width modulated signal to drive the power digital switches. Any RF energy created is contained within the cabinet. The user must maintain the integrity of the enclosure and shielding gaskets. Any added cabinet penetrations must be made with grounded conduit systems. Do not operate the amplifier with any panels or screens removed or with attaching hardware missing.

Operation of this equipment (in the United States) is governed under the CODE OF FEDERAL REGULATIONS Volume 47 part 15 sub-part J.

For control of E.M.I. emissions to the power line, the optional facilities line filter must be installed in the three phase service to the amplifier.

NOTE

THIS EQUIPMENT COMPLIES WITH THE REQUIREMENTS IN PART 15 OF FCC RULES FOR A CLASS 'A' DEVICE. OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA MAY CAUSE UNACCEPTABLE INTERFERENCE TO RADIO AND TV RECEPTION REQUIRING THE OPERATOR TO TAKE WHATEVER STEPS ARE NECESSARY TO CORRECT THE INTERFERENCE.

Vol.47 Code of Federal Regulations sect.15.816

Standard factory connection is for 480 V wye unless otherwise requested. Note that if one of the delta connections must now be used, the main contactor may have to be changed to a larger size as well as the wiring to the power transformer primary in each power bay.

## 2.6 Setup and Turn On Checkout Procedure

Perform the checks of this section in order; especially if this is your first amplifier/shaker installation.

### 2.6.1 Verify Line Input Voltage

De-energize the power feeding the amplifier, open the rear door of SYSTEM CABINET #1, pull out the door interlock switch to the override position. Temporarily remove fuses F1 and F2 that supply the amplifier's internal control power. Disconnect field cables "E & F". Re-energize the power feeding the amplifier. Verify the voltage on the line side of the amplifier circuit breaker. If the voltage is more than 10% high or low de-energize and change the primary taps on the power transformer according to Table 2-1.

| Line Voltage | Tap | Input on Term. | Jumpers |
|---|---|---|---|
| 380 V WYE | - 5 % | 5A,5B,5C | 3A-3B-3C |
| 400 V WYE | Nominal | 5A,5B,5C | 2A-2B-2C |
| 416 V WYE | + 5 % | 5A,5B,5C | 1A-1B-1C |
| 460 V WYE | - 5 % | 6A-6B-6C | 3A-3B-3C |
| 480 V WYE | Nominal | 6A-6B-6C | 2A-2B-2C |
| 504 V WYE | + 5 % | 6A-6B-6C | 1A-1B-1C |

Table 2-1

LINE VOLTAGE CONNECTION CHART

Other, less common, voltage combinations are possible.

### 2.6.2 Check Connector Installations

For the following section please refer to LING drawings 713118 for the over all block diagram of the amplifier and 713612 for all ribbon cable interconnects.

Insure that all power module ribbon cables and power connectors are installed correctly and fully seated. The ribbon cable color stripe must align with the pin 1 triangle on its respective header.

There are four connectors on the rear of the LOGIC MODULE. The two 20 pin ribbons route to the two interlock adapter boards accessible on the rear A.C. relay panel.

The 34 pin connector furthest from the signal input BNC connector connects to the I/O module, the 34 pin connector closest to the input signal jack is for options and accessories.

Install all ribbon cables with their color stripes to the right, as viewed from the rear. There are five ribbon cable connections on the rear of the I/O module; there are four 40 pin connectors, one for each of the four possible POWER CABINET positions, the fifth 34 pin connector routes to the MODULATOR. Review the supplied ribbon cable interconnect drawing to confirm all ribbon cable interconnects. Do not plug or unplug any cables with power applied to the amplifier. Even with the amplifier "off", control power is still distributed throughout all ribbon cables.

### 2.6.3 Check Shaker Cables

Check correctness of the external cabling; especially the polarity of the field cables (terminal "E" is positive). If this is wrong, the suppression diodes in the shaker will be destroyed. The "N" lead is the shaker body ground. The "H" and "J" cables conduct drive power to the shaker armature, red is H black is J.

### 2.6.4 Check Switches in Control Module

Perform this step only if a problem is encountered with the trip interlocks or FAULT indicator after making all connections called for on the SYSTEM INSTALLATION drawing supplied.

Set or verify the settings of the interlock enable/disable switches in the control module by withdrawing the MODULATOR from the front just far enough to be able to remove the top cover. It should not be necessary to disconnect any of the rear connectors.

The LOGIC/MODULATOR is one large circuit board and contains two banks of DIP switches and several "suitcase" shaped jumpers. The circuit board is silkscreened with legends identifing these switches and jumpers.

The normal settings are:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SN1 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 |
| | on | on | on | on | on | on | on | on |
| SN2 | -1 | -2 | -3 | -4 | -5 | -6 | -7 | -8 |
| | on | on | on | on | off | off | off | off |

NOTE

If the optional USQ-103 system automation controller is installed set switch SN2-5 to "on".

The individual "suitcase" jumpers are defined and shipped setup as:

| | | |
|---|---|---|
| X1 | Install for input signal referenced to ground | INSTALLED |
| X2 | Select trip polarity of Aux.1, [install for trip on lo level] | STORED |
| X3 | Install to disable Aux.7 | INSTALLED |

Additionally, there are the following "cut-trace" jumper options which may be setup at this time:

X5 Cut trace and install a 10 mfd capacitor (50 V, Tantalum) if ac input signal coupling is needed.

X6 Substitute jumper for the standard "alarm silence" switch if silencing the audible alarm is not desired.

The function of each switch is listed in Table 2-2.

CAUTION

These interlocks are provided to trip the amplifier off-line in the event of an internal or external malfunction. System damage may result if a required interlock is disabled. Change the switches in Table 2-2 only for servicing or if you are changing the system configuration.

| Switch | Trip Function ( enabled = on ) |
|---|---|
| SN1-1 | Low voltage power supply |
| " -2 | Door interlock(s) |
| " -3 | Soft start failure |
| " -4 | Emergency stop |
| " -5 | Field off |
| " -6 | Shaker overtemp or low hydraulic |
| " -7 | Shaker overtravel |
| " -8 | Shaker cooling unit fault |
| SN2-1 | Isolated external interlock |
| " -2 | Aux.7 (user defined thru J2) |
| " -3 | System over current |
| " -4 | System over voltage |
| " -5 | Remote controller (USQ-103) |
| " -6 | Polarity of SN1-5 trip,low = on |
| " -7 | " " SN1-6 trip,low = on |
| " -8 | " " SN1-7 trip,low = on |

Table 2-2

CONTROL MODULE SWITCH DEFINITIONS

Re-install the LOGIC/MODULATOR module, plug in all ribbon cables (all pin one's are to the right as viewed from the rear).

### 2.6.5 Check Rotation of Motors

Check the rotation direction of the pump motors in the shaker cooling unit by momentarily turning the control power on and then off; check shaft rotations as they coast to a stop. If rotation is incorrect, exchange any two wires to the three phase motor.

### 2.6.6 Check Front Panels & Fans

With the gain switch in the 'RESET' (detent) position; press the control power 'STANDBY' switch then the "PA ON" button. This will bring the amplifier rails on and all auxiliary equipment on. All cabinet booster fans should be on as well as all POWER MODULE front panel fans. No indicators marked 'SERVICE' should be illuminated on any of the power modules; if so, there are one or more blown fuses in any module with one of these indicators lit.

The system is still operational, but will not be able to operate at full drive power.

The following indicators should be on at this point:

Operator's panel - "E.STOP" on if safety circuits are closed

"STANDBY" on when SCU, FIELD & auxiliary equipment is on

"DRIVE ACTIVE" on when rails supply is on

Modulator panel - "POWER ON" on when internal +12 Volts is on

"FAULT" on if the gain control is in reset or a trip condition exists, check the message display unit on the I/O module

I/O module panel - the display unit will be internally illuminated and displaying messages or other information

Slave logic panel- if a fault is in progress, the corresponding indicator will be on, the ready light will be on for no faults or if the key switch is 'off-line'

### 2.6.7 Low Level Functionality Test

Reconnect the shaker field that was temporarily disconnected in Step 2.6.1. Re-energize the Amplifier/Instrumentation System and connect the DRIVE SIGNAL and instrumentation as required by a typical test (this may be a bare table test; as long as there is a feedback accelerometer attached to the shaker table). Apply a low level signal to the rear BNC jack and increase the amplifier gain to observe a response from the shaker.

THIS COMPLETES THE FUNCTIONAL SETUP AND CHECKOUT OF THE AMPLIFIER.

### 2.6.9 Adjustments

There are NO adjustments whatever in the POWER MODULES.

The CONTROL MODULE has four (4) front panel adjustments that may be set at this time. All are factory set to nominal values. These are:

| | | |
|---|---|---|
| OVERLOAD | @ | (value of subsection 7.1.5) |
| OVERVOLTAGE | @ | 122 Volts ac |
| OVER DRIVE | @ | 100 Volts ac |
| OUTPUT OFFSET | @ | < ± 20 mVolt dc |

The OVERDRIVE adjustment may be set at any value desired since this only causes the front panel OVERDRIVE warning light to illuminate.

Great care should be used in re-adjusting the OUTPUT OFFSET; this controls the dc offset to the shaker. If an output matching transformer is used between the amplifier and the shaker, this offset control must be set as close to zero as possible, to prevent saturation of any output transformer.

If it is felt necessary to re-adjust the OVERLOAD, OVERVOLTAGE or OUTPUT OFFSET, refer to Section 7 of this manual for CALIBRATION and ADJUSTMENT.

The dampener assembly #714130 located in each power cabinet is adjustable and must be set for the number of power modules installed in each power cabinet. Set the value of the adjustable resistor to the following approximate values.

| NO. MODULES/BAY | DAMPER RESISTOR SETTING |
|---|---|
| 12 | 50% |
| 10 | 65% |
| 8 | 80% |
| 6 | 100% |

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SECTION 3
OPERATION

## 3.1 LOCAL CONTROL

The DMA amplifier may be operated at full rated power from dc (if dc coupling is used throughout the drive signal chain) to 2000 Hz and linearly derated to one half output power at 3000 Hz. Operation is through the local operator's panels or remotely through connector J2 on the rear of the LOGIC module. This section covers the local control operation only. See Sub-Section 4.8 for remote control operation. There are five indicators, four adjustments, an alarm silence switch and one gain control with a combined reset switch on the operator's control panel along with Emergency Stop and Amplifier Control Buttons.

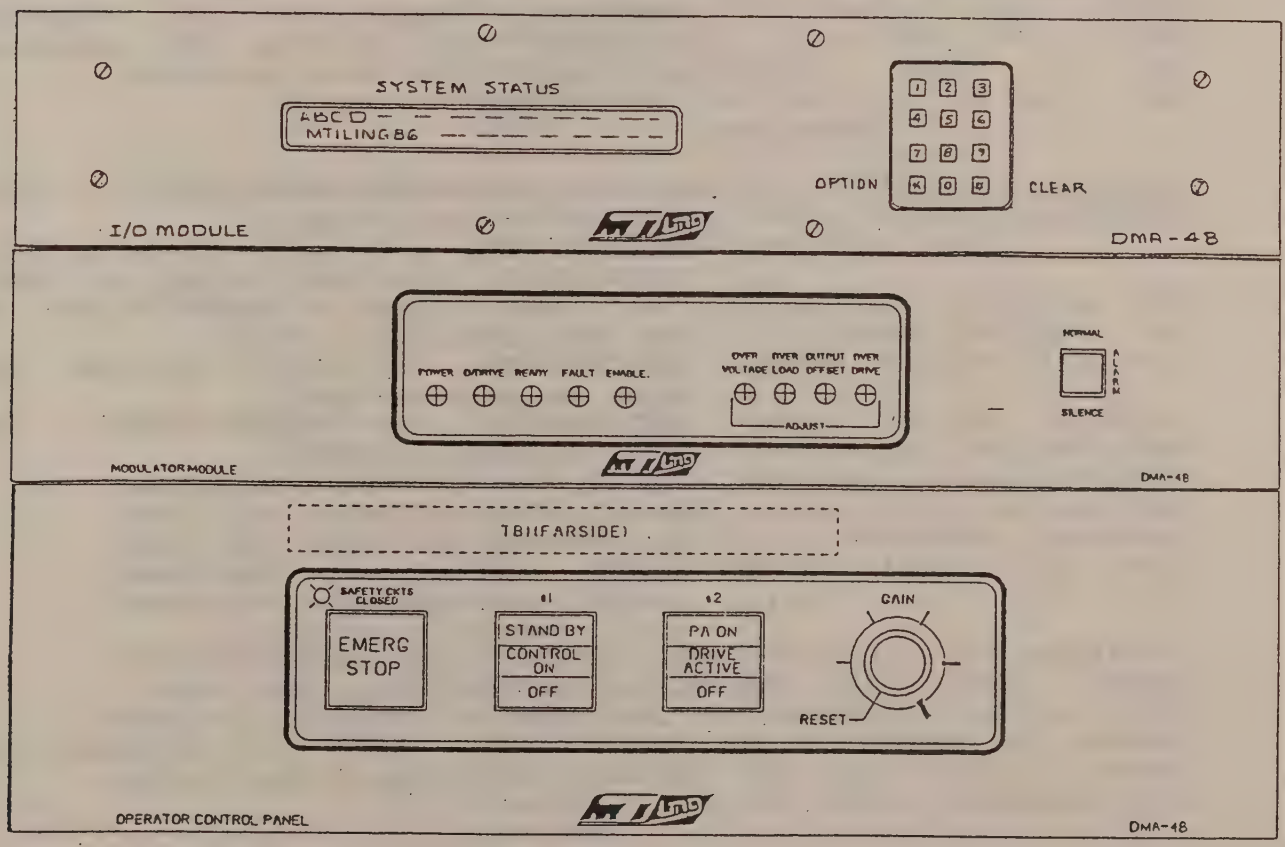



Figure 3-1

LOCAL OPERATOR CONTROL PANEL

Indicators-

POWER — Illuminates to indicate basic functionality of the power supply for the Control Module and Modulator.

OVERDRIVE — Illuminates at the drive voltage level set by the OVERDRIVE adjustment pot on the front panel; usually set just below clipping or just below the overvoltage trip level.

READY — Illuminates when no fault condition exists; extinguishes approximately 0.5 sec after a fault, allowing time to drive the output to zero before it is gated to a high impedance off condition.

FAULT — Illuminates as a general problem indicator. There are (13) possible functions that can trip the amplifier off-line to this fault condition.

These are:

1. LOW VOLTAGE POWER SUPPLY, the ± 12 Volt supplies are out of spec.
2. UNDERVOLTAGE, main rail voltage is low.
3. OVERVOLTAGE, main rail voltage is high.
4. PHASE LOSS, there is excess ripple on the main power supply rails.
5. OVERCURRENT, the output current set point has been exceeded.
6. OVERVOLTAGE, the output voltage set point has been exceeded.
7. Aux.#1, user definable trip input
8. Aux.#2, user definable trip input
9. Aux.#3, user definable trip input
10. Aux.#4, user definable trip input
* 11. Aux.#5, user definable trip input (trip polarity = low only)
* (accessible only through J2)
12. EXT., user definable trip input (this input is optically isolated)
13. REMOTE Trip, active low available at J2 only, this trip is not latched.

| | |
|---|---|
| OVERDRIVE ADJ. | This adjustment is set as desired to provide a warning indicator to the operator that a voltage level has been or is about to be exceeded. This is usually set to cause the OVERDRIVE indicator on the front panel to illuminate just before clipping occurs on the output or just prior to reaching the overvoltage trip point. |
| OVERVOLTAGE ADJ. | This adjustment sets the voltage level at which the amplifier will trip 'off-line'. The FAULT indicator will be on when this condition occurs. Refer to the CALIBRATION Section 7.3 to set this level. |
| OVERLOAD ADJ. | This adjustment sets the average current level at which the amplifier will trip 'off-line'. The FAULT indicator will be on when this condition occurs. Refer to the CALIBRATION Section 7.4 to set this level. |
| OUTPUT OFFSET ADJ. | This adjustment sets the dc component in the output. Refer to the CALIBRATION Section 7.2 to set this level. |
| ENABLE | Illuminates when the gain switch is NOT in its 'off' or reset position i.e. the amplifier is able to drive it's load. |
| ALARM SILENCE | Setting this switch to the "SILENCE" position mutes the internal audible alarm which operates whenever a fault condition exists. An LED on the switch reminds that the switch is in the "SILENCE" position. This switch does NOT disable the fault circuits. |
| GAIN CONTROL | This knob sets the gain of the amplifier. Zero gain is at the 'reset' detent position; maximum gain is at full CW. Faults may be cleared by turning this control to the 'reset' detent position, if the fault condition has cleared.<br><br>Maximum voltage gain of the amplifier is 80X (38 dB). |

Maximum power gain of the amplifier ( 48 modules installed ) is approximately 90 dB.

Normal operation of this amplifier is in a system driving a shaker and incorporating a controlled signal source which is servoed from a feedback accelerometer signal from the shake table as indicated in Figure 3-2. Refer to the specific installation drawings supplied with your system.

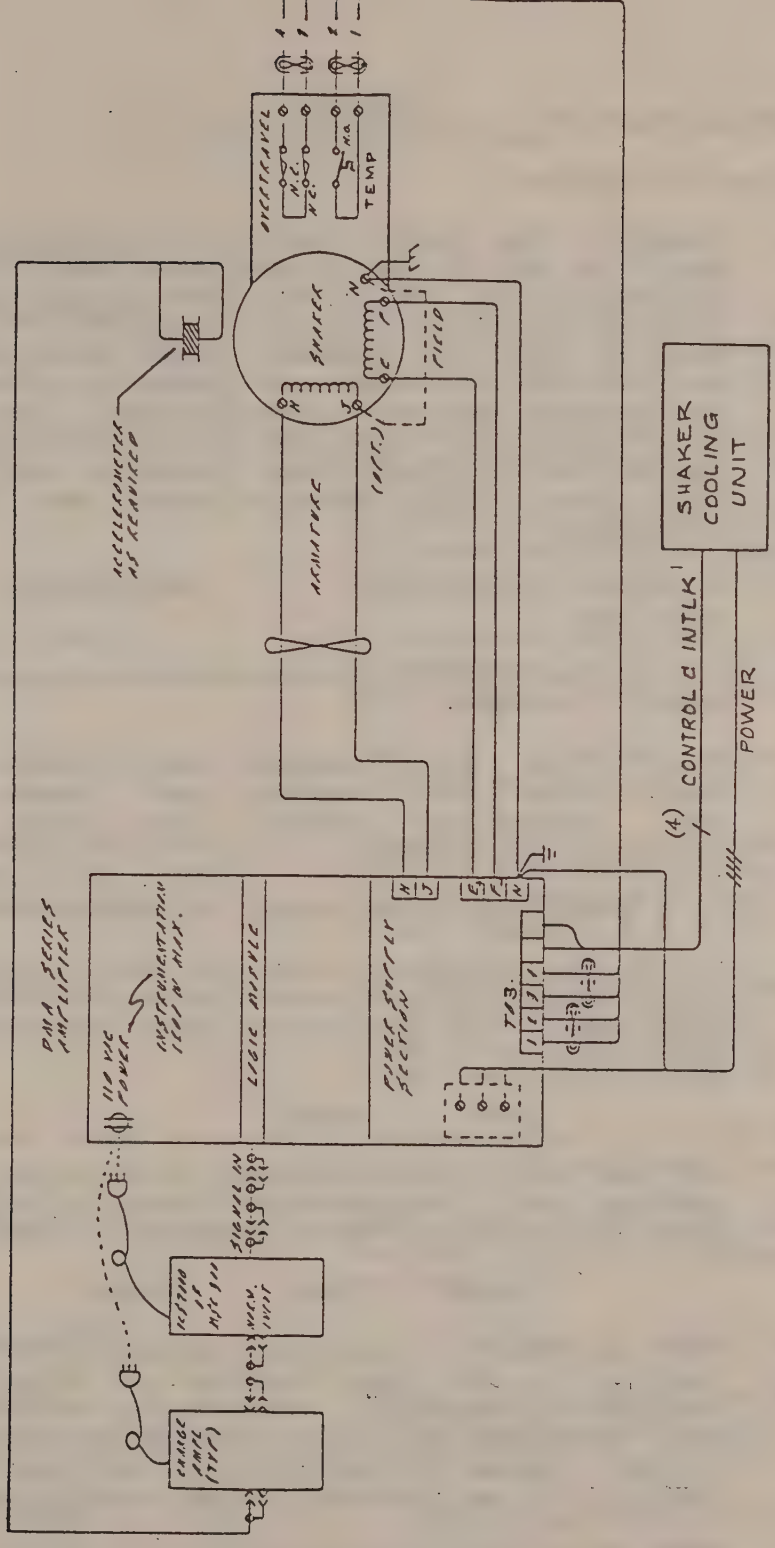



Figure 3-2

STANDARD SYSTEM DIAGRAM

## 3.2 INITIAL TURN-ON

To turn on the system:

1. Energize the power feed to the amplifier, check to see that the Emergency Stop push button is illuminated indicating that the safety circuits are closed. Press the control power on button (operator control #1) and observe that the 'Standby' light illuminates. Turn the gain control to 'Reset' and press the 'PA on' push button and observe that the 'Drive Active' light comes on. At this point all auxillary systems should be on and all system faults should have clearedl; verify by checking the 'System Status' message display unit, which should be displaying:

   MTI/LING hh:mm:ss.t MONITORING
   GAIN DOWN

2. Set up the control instrumentation required to control the test.

3. Start the drive signal source and advance the amplifier's gain control as required to allow the controller enough loop gain to capture and servo the system.

### 3.2.1 Normal Operating Condition Indicators

It is recommended to have the GAIN control turned down to the 'reset' position when powering up the system. At this time, the only front panel indicators that should be on are:

POWER FAULT

If the amplifier is brought up with the gain control enabled or if the amplifier trips 'off-line' during a test the indicators that should be on are:

POWER FAULT ENABLE

This is normal, reset the amplifier by turning the GAIN control to the reset position or allow the optional external controller ( USQ-103) to reset the system. If the offending trip condition has not been cleared, the system status display unit will be displaying messages relating to any abnormal system conditions.

With the system delivering power to a load or waiting to drive, the indicators illuminated will be:

POWER READY ENABLE

## SECTION 4
## TECHNICAL INFORMATION

### 4.1 Specifications

| | | |
|---|---|---|
| OUTPUT VOLTAGE | - | 110 Volts rms at rated current.<br>120 Volts rms at reduced current.<br>[absolute maximum] |
| OUTPUT CURRENT | - | 46 Amps rms/module (Sine)<br>42 Amps per module at increased voltage.<br>110 Amps peak/module (Random)<br>37 Amps rms/module (Random)<br>[rms value is peak/sigma] |
| POWER OUTPUT | - | 5 kVA/module apparent power to 60kVA<br>5 kW/module real power,<br>power supply limited to 50 kW |
| POWER FACTOR | - | No limit, 0-50 kVA output<br>limited to 0.8 p.f. for 50 - 60 kVA |
| FREQUENCY RESPONSE<br>( Sine Mode )<br>(resistive load) | -<br><br>- | +/- 1db, Full power from dc to 2000 Hz<br>rolling off to half power at 4000 Hz.<br>with a 6dB/Octave slope.<br>( see Appendix A ) |
| DISTORTION | - | (at rated output) THD Less than:<br>0.5% from dc to 1000 Hz<br>1.0% from 1000 to 2000 Hz<br>3.0% from 2000 to 4000 Hz |
| HUM and NOISE | - | Greater than 60 dB below full output, with shorted input |
| DC STABILITY | - | Less than 0.05% of full output voltage with ± 10% change in line voltage. |
| INPUT DRIVE | - | 1.5 Vrms into 10 kOhms for full output |
| ISOLATION | - | Output is isolated, may be grounded, "J" terminal only. See sub-section 2.4.3 |
| SOFT START | - | 0.5 sec from "OFF" to full power |

| | | |
|---|---|---|
| SHUTDOWN | - | After a trip condition is detected, amplifier is ramp "commanded" to 0 Volts from full output within 10 ms. and clamped to dissipate shaker energy for 1 sec. then output is gated to a high impedance 'off' condition. |
| COOLING | - | 70 CFM (.033m3/s) per module, 2750 BTU/hr/module (.806kW) rejected to the air (full output)<br><br>The POWER CABINET booster fan moves approximately 1200 CFM. |
| DC FIELD POWER | - | High range (335/340 shakers)<br>Low range (300/335 shakers) |
| DIMENSIONS (per cabinet) | - | HEIGHT 77 in (1.96m) WIDTH 22 in (.56m) DEPTH 31 in (.79m) |
| WEIGHT | - | Approximately 1200 lb (545 kg) ( with 12 POWER MODULES installed) |
| REMOTE CONTROL | - | Full capability for both remote control and monitoring (see Sections 4.8 and 9.0.1) |

## 4.2 Standard System Ratings

| Shaker Model | Amplifier DMA-48/X | # Sine Force | # Rand Force |
|---|---|---|---|
| B340 | DMA-48/44T | 36000+ | 34000 |
| | DMA-48/28D | 36000 | 25000 |
| B335 | DMA-48/18T | 20000 | 14000 |
| | DMA-48/24D | 20000 | 16000 |
| D300 | DMA-48/12T | 9000 | 7000 |
| | DMA-48/20D | 9000 | 7000 |

"D" = direct coupled
"T" = transformer coupled

Table 4-2

## 4.3 System Theory Of Operation

### 4.3.1 General

The DMA Series of Amplifiers operate in a Class D mode, utilizing the principles of pulse-width modulation to amplify large amounts of power very efficiently. By modulating a high frequency signal and filtering out the unwanted switching frequencies a faithful reproduction of the input signal is produced on the output.

The system consists of a SYSTEM CABINET and one to four POWER CABINETS. The SYSTEM CABINET houses the field supply, an output transformer (for some systems), all control relays and the master control logic. Each POWER CABINET mainframe houses an unregulated power supply for the power modules, the required number of power modules, and a slave logic module driven from the SYSTEM CABINET's I/O module which, in turn, is driven from the MODULATOR module which is the master control for the system.

### 4.3.2 Power Modules

The system operation is most easily understood by starting with the basic power conversion that takes place in the power modules; please refer to Figure 4-1.

Each power module is basically a full-bridge configuration consisting of switches S1-S4, and a L-C filter L1, L2, and C1. Dc power of approximately 230 Volts is brought into the module on P1 connector terminals 1 and 2.

Each half of the bridge (S1-S2 and S3-S4) switch at 56 kHz and with no signal input have a 50% duty cycle, in phase and thus no output voltage will appear across the output terminals (P1-3/P1-6 and P1-5/P1-7) any high-frequency noise will have been filtered out by the L-C filter.

If a sine-wave input signal is present, each half of the bridge will be duty cycle modulated at a sine-wave rate; each side is driven out of phase so that an amplified sine wave appears across the output terminals.

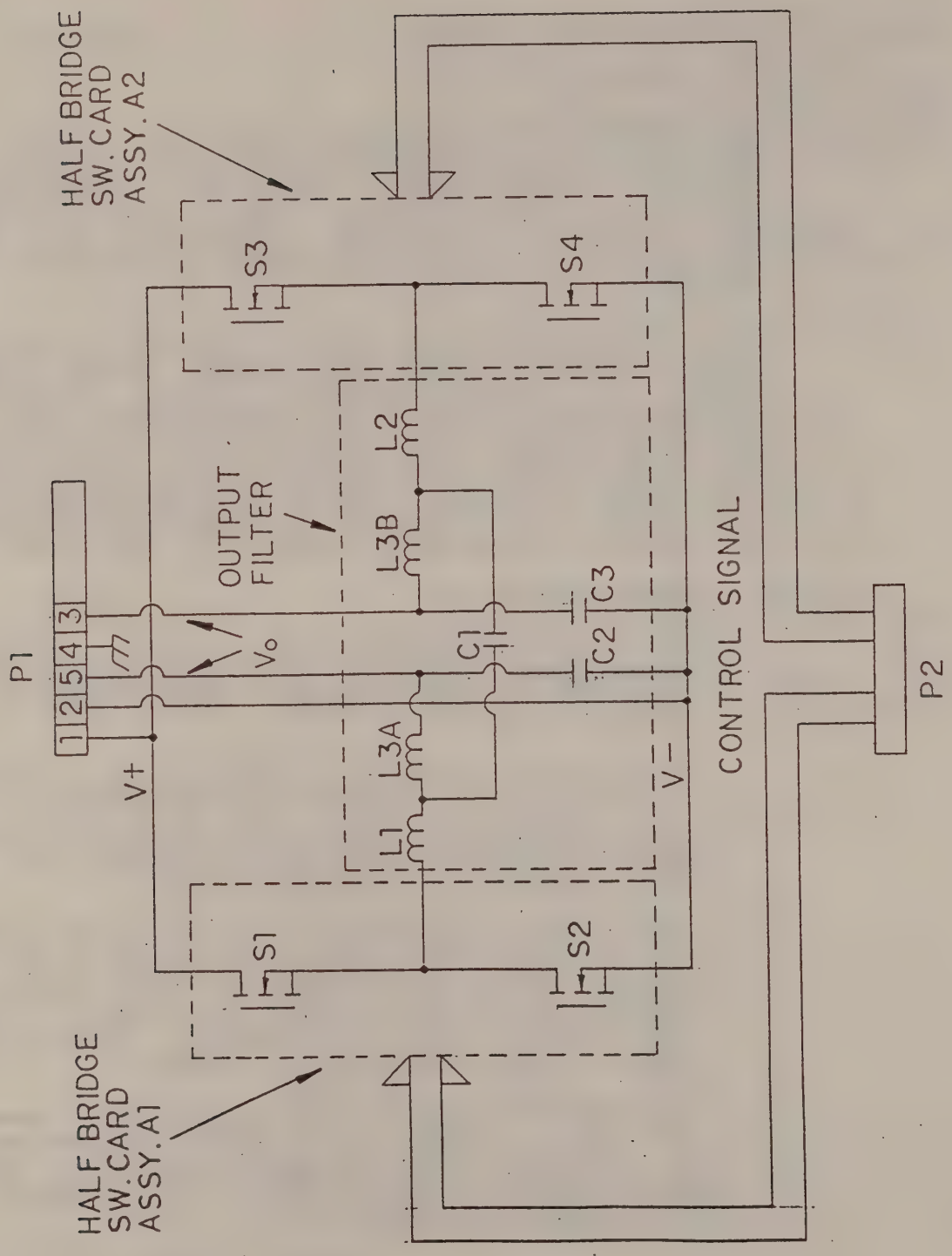



Figure 4-1

POWER MODULE BLOCK DIAGRAM

### 4.3.3 Logic Modules Set (MODULATOR + I/O + SLAVE LOGIC)

This logic module set serves two functions:

1. To provide the pulse-width modulated drive signals for the POWER MODULES

2. To monitor all of the protective circuits of the system.

The modulator functions by amplifying the input signal and summing it with the system output feedback signal to generate an error signal; this signal is then compared to a precision triangle waveform to generate a pulse-width modulated logic signal to drive one half of the bridge in the power modules. The error signal is polarity inverted to generate the drive signal for the other half of the bridge.

If a system overcurrent condition is experienced, a clamp circuit will reduce the drive signal amplitude until the current is within limits. The Drive Power Supply provides a high frequency square wave which each power module rectifies as a bias supply for module control and drive power.

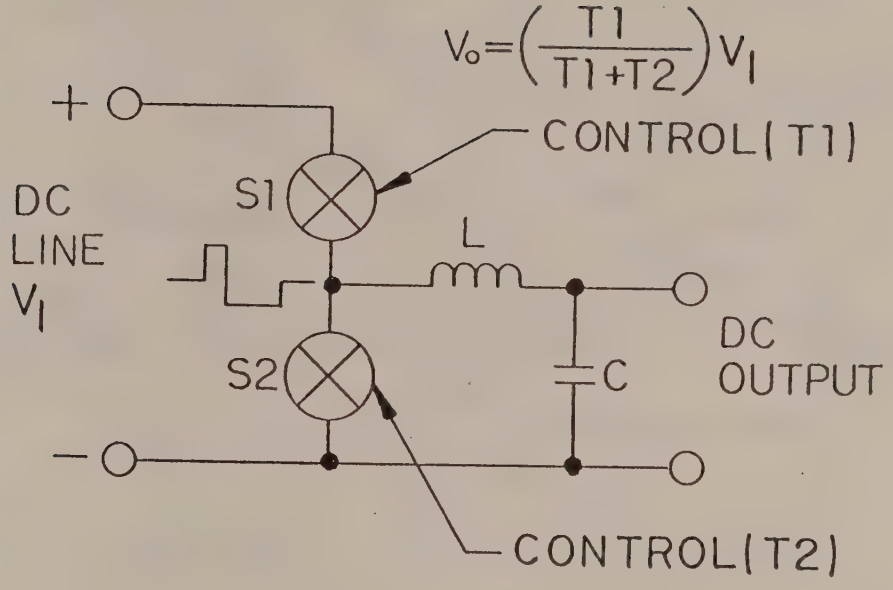
The monitor circuits are spread between the SLAVE LOGIC modules, the I/O module and the MODULATOR module. Internal interlocks are handled through the SLAVE LOGICs and the I/O module. External interlocks feed into the system MODULATOR. All conditions must be satisfied or within limits in order for the amplifier to be 'on-line' and able to drive the shaker. Additionally, the I/O module houses the internal housekeeping microprocessor wich monitors all external and internal fault conditions and reports them on a local LCD display as well as thru the built-in RS-232 data link for use by a remote CRT, printer or host computer.

## 4.4 Digital Amplifier Tutorial

This section is included as an aid in understanding the theory of operation of a digital amplifier. Switching power supplies have gained wide acceptance in most types of modern electronic equipment due to their high efficiency and small size, in larger sizes they cost less than their linear counterparts. The same principles used in switching power supplies can be used to create a digital amplifier as described below.

The simplest form of a switching dc power supply is the buck regulator depicted in Figure 4-2. Switches S1 and S2 are alternately switched on and off at a high rate, typically 20-100 kHz. The voltage at the junction of S1 and S2 will be a rectangular waveform with an average value equal to the duty cycle, or ratio of the time that S1 is on to the total period multiplied by the dc rail voltage. If this waveform is passed through an L-C filter with sufficient attenuation to filter out the majority of the switching harmonics, then only the average or dc value will be present at the output terminals. Thus, by controlling the duty cycle, we can vary the output voltage from 0 to the input line voltage, and a feedback loop could automatically make adjustments to correct for ripple or line/load changes to produce a precise output.

If Figure 4-2 is modified to include a centertapped power supply with the centertap connected to ground, the output voltage can be varied from V- to V+ as the duty cycle is varied from 0 to 100%. If, instead of a fixed ratio, the duty cycle is varied back and forth from 0 to 100% at a sinusoidal rate, then the output voltage waveform will be a sinewave of 2 Volts peak-to-peak. If the duty cycle was only varied from 40-60%, then the output sinewave would only be 0.4 x the supply Volts, peak-to-peak. The modulation frequency may be increased until the L-C filter will no longer pass that frequency. The half bridge amplifier configuation of Figure 4-3 performs well, but high voltage devices must be used to achieve a high voltage output. The circuit of Figure 4-4, a full bridge configuration, will achieve the same output voltage, but with half of the power supply voltage. It also does not require a centertapped power supply to operate, and as long as the power supply is floating either output terminal may be grounded.

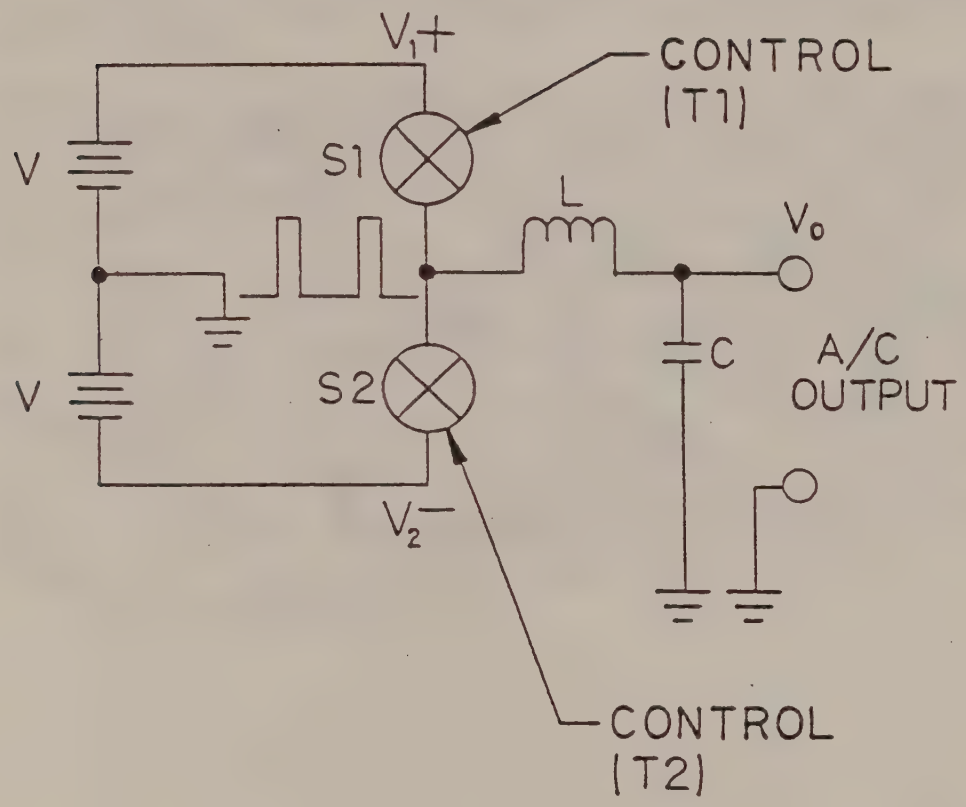



S1 and S2 are power switches with "on" time duty cycles of T1 and T2 respectively.

Figure 4-2

SWITCHMODE DC POWER SUPPLY

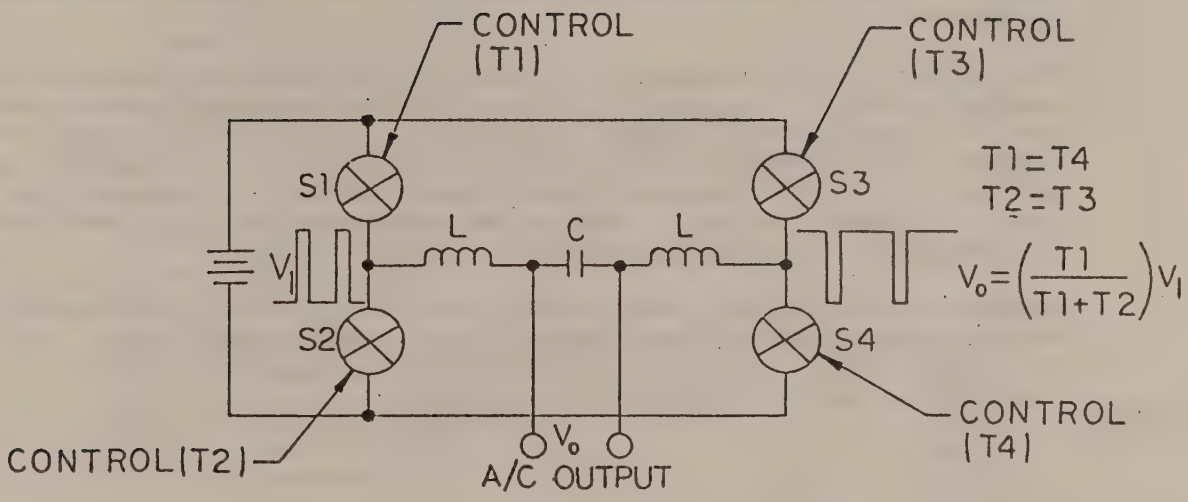
$$V_o = \left(\frac{T1-T2}{T1+T2}\right) V$$




S1 and S2 are power switches with "on" time duty cycles of T1 and T2 respectively.

Figure 4-3

HALF BRIDGE SWITCH MODE AMPLIFIER




S1, S2, S3 and S4 are power switches with "on" time duty cycles of T1, T2, T2, and T1 respectively.

Figure 4-4

FULL BRIDGE SWITCH MODE AMPLIFIER

## 4.5 Power Module Description

Each power module is a high-frequency pulse-width modulated power converter with a rating of about 5 kVA. The topology is a full-bridge with the output filter contained inside the module to minimize EMI/RFI emissions. The switching frequency is 56 kHz and each half of the bridge is modulated out of phase, resulting in an effective 112 kHZ switching rate.

Each power module contains two (2) identical half bridge switch cards. The two quadrants on each card are switched 180 degrees out of phase.

The power that the module switches to the load is supplied from an unregulated dc supply of about 230 Volts through power connector P1. Local control power is derived independently from a 56 kHz square wave which is rectified and regulated at each quadrant switch. Switch command signals are optically isolated and routed via a ribbon cable. Ample heat sinking and two cooling fans insure safe thermal operation.

Internal faults that result in blown FET switch fuses turns on the switch card's local neon lamps; light from these lamps is routed to the front panel via fiber optic cables to give a panel indication of the internal fault.

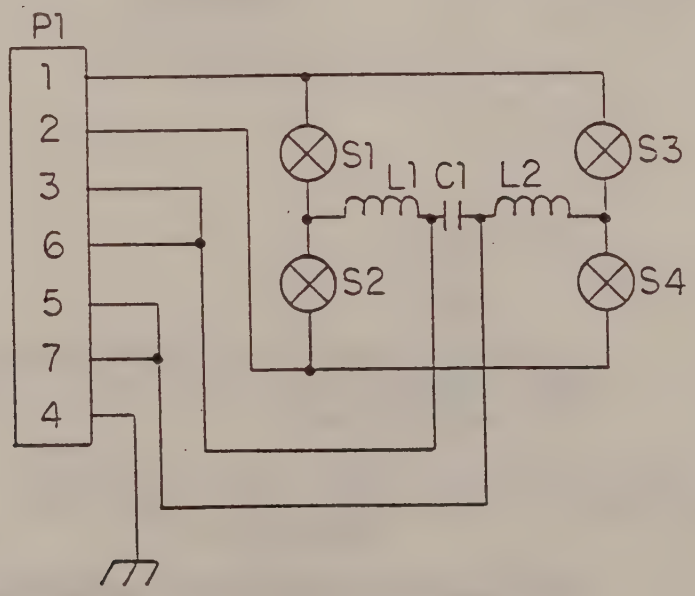



Figure 4-5

POWER MODULE, SIMPLIFIED DIAGRAM

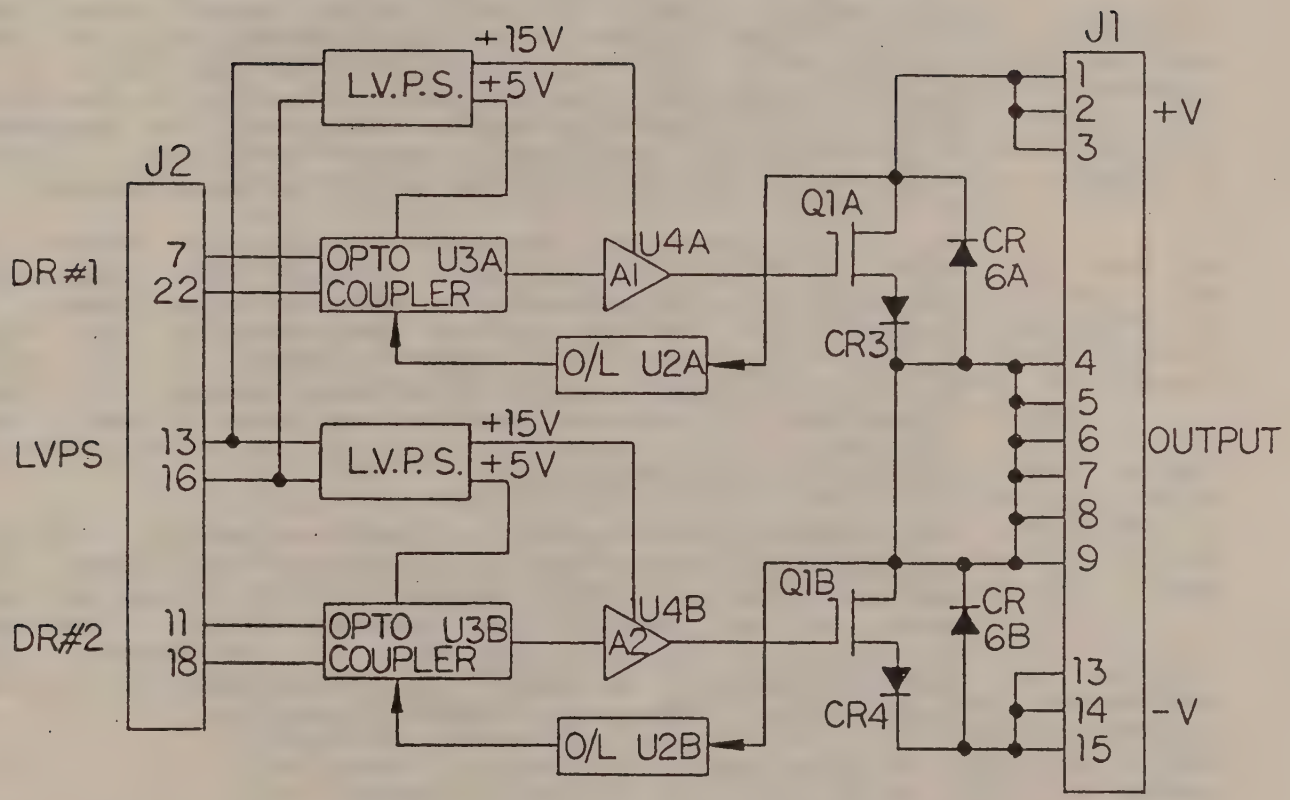



Figure 4-6

SWITCH CARD BLOCK DIAGRAM

### 4.5.1 Switch Card Circuitry

The switch card contains two identical high-speed high-power electronic switches wired in a half bridge configuration. Power is routed in and out on a 15-Pin Molex type connector and drive signals enter via a 26-Pin ribbon cable.

Each switch section is comprised of five power MOSFETS in parallel, which are individually fused so that if one should short it will clear itself from the circuit and the switch will continue operating at 80% capacity. A neon lamp will light in the case of a faulted transistor, and the light is routed to the front panel via a fiber optic cable. Each FET is protected from voltage transients with a Zener diode 'gate-to-source' and a MOV varistor 'drain-to-source'.

The drive signal that determines whether the switch is "on" or "off" is optically isolated with high-speed optocoupler U3. To achieve very fast switching times, a power driver (U4) is used and Q8-11 provide the high current required. The power consumed by the drive circuitry is supplied by a drive power supply. A 56 kHz square wave is isolated by T1, rectified by CR8-11 and filtered by C1-3; regulator U1 drops the voltage down to 5 Volts for the optocoupler.

If an overcurrent condition exists in a switch, it will manifest itself by an excessive voltage drop across the switch. When the voltage exceeds about 7 Volts, Q12 will turn on and trigger the current limit one-shot multivibrator U2 which inhibits the optocoupler and drive circuitry. This will repeatedly occur at a 10 kHz rate if the overcurrent condition persists.

### 4.5.2 Power Module Filter

The amplifier output power is generated by pulse-width modulating a 56 kHz square wave. For a reasonably pure output at the desired frequency, the switching frequency and its harmonics must be filtered out; this is done by the power filter in each power module.

Switching noise has both differential and common-mode components. The first stage of the filter is a differential mode L-C made from L1, L2, and C1; this removes the bulk of the noise energy. The common mode energy is transferred back into the power supply via common mode inductor L3 and capacitors C2 and C3. Any remaining noise on the output is removed by a second stage differential filter L4 and a capacitor, C7, located at the amplifier "H" & "J" output terminals.

## 4.6 Logic Module Description

### 4.6.1 Logic Module Modulator Circuitry

A simplified block diagram of the Logic Module Modulator Circuitry is depicted in Figure 4-7; the reference desiginators are the same as used on the card. This circuitry generates all of the drive signals for the power modules, allowing them to perform as a high performance power amplifier.

System timing is controlled by crystal oscillator U1A which runs at 3.58 MHz; this signal is divided down to 56 kHz by U2 to generate the switching frequency. The drive power requirements of the power modules are provided by a square wave power supply comprised of Q4, Q5, Q13 and Q14. The 56 kHz signal is also converted into a precision triangle by integrator U5.

The input signal enters on BNC connector J5 and is controlled by gain pot R35 and amplified by U14B. The amplifier output voltage feedback is scaled down to signal levels by feedback amplifier U6. These signals are summed by the error amplifier U4B with sufficient gain to insure a low distortion output waveform.

The system output current is sensed by a Hall effect sensor in the mainframe and transmitted to the logic card via J1. This low level signal is amplified by U13, and if it exceeds a threshold set by the system current limit adjustment trimpot R162, it will clamp the error voltage via U8.

The error voltage is compared against the triangle by comparator U9, which creates the pulse-width modulated drive for one half of the power modules. The error signal is inverted in polarity by U7 and also compared against the triangle by U10 to create the drive for the other half of the power modules. Modulation limits are placed on the drive signals by gate U31; U11 inserts a dead time into the switching to prevent one switch from turning on before its mate has turned off. These signals are buffered by power drives U12 and U32 and control the switching of all of the power modules.

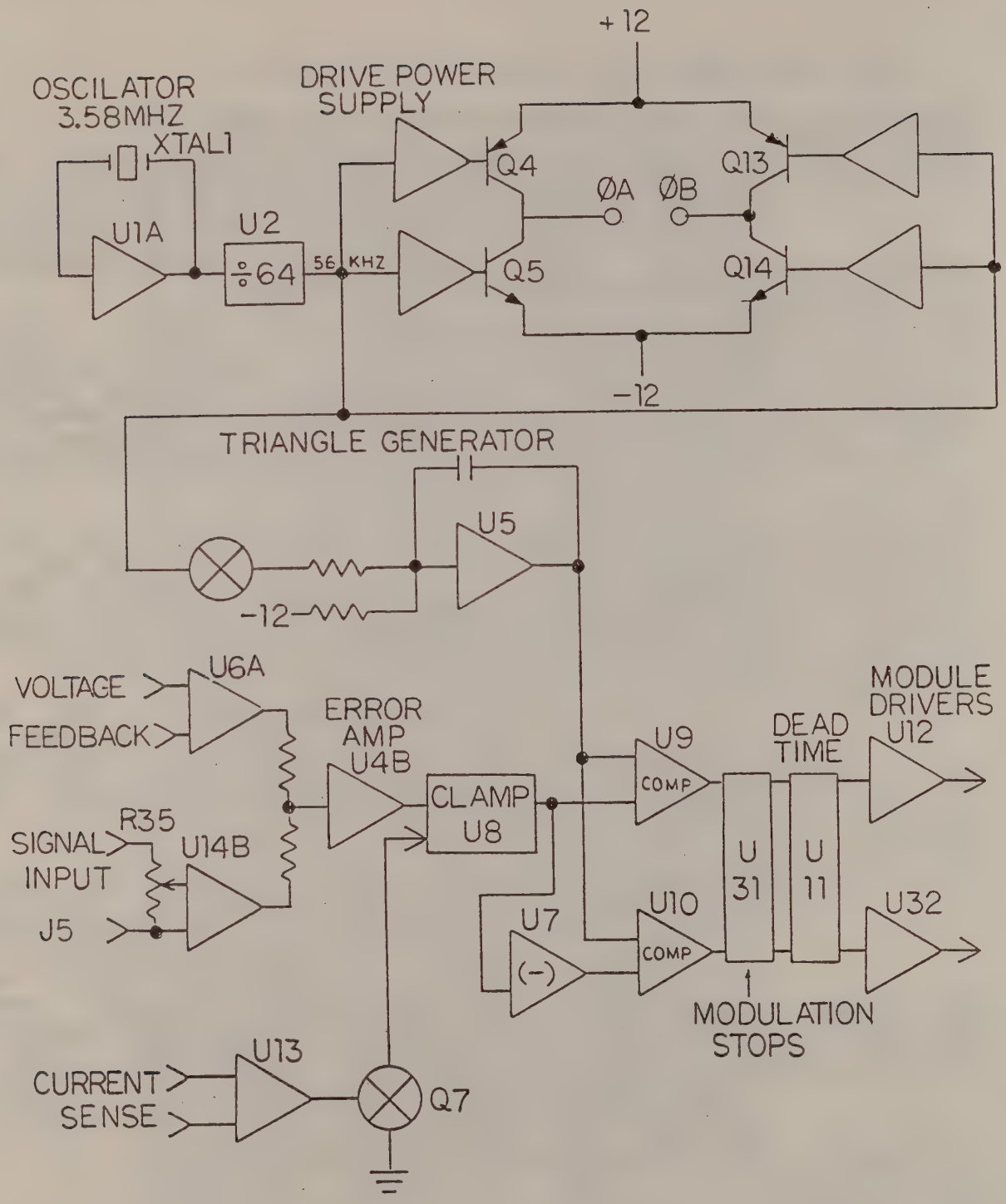



Figure 4-7

MODULATOR BLOCK DIAGRAM

### 4.6.2 Interlock/Protection Circuitry

A simplified block diagram of the interlock and protective circuitry is depicted in Figure 8; the reference designators are the same as used on the card itself. This circuitry provides the following functions:

A) AUX 1 THROUGH
AUX 4 Interlocks - four separate interlocks from external equipment, the polarity of each being individually settable by switch S1 and exclusive OR gate U23. NOTE: AUX 1 is wired to field control relay K1 and would normally be used with the cooling sensor.

B) AUX 5 Interlock
Similar to AUX 1 - 4, but not polarity selectable; may be disabled by jumper X3.

C) EXT CONTROL
An optically isolated external fault input. This input requires 12 Volts to enable.

D) OVERCURRENT
A load overcurrent trip is adjustable from 0 to rated current by front panel trimpot R72. It is normally set at slightly above rated current.

E) OVERVOLTAGE
An output overvoltage is adjustable from 0 to rated output voltage by front panel panel trimpot R71. It is normally set at slightly above rated output voltage.

F) L.V.P.S. (Low Voltage Power Supply)
Monitor the internal +12V logic power supplies by U29 and faults if either decreases below 10 Volts.

G) HI LINE
The 3 phase ac input is monitored via the amplifier dc supply voltage, which is proportional to the line. Amplifier U27B translates the nominal 170 Volts to a lower level and U28A will generate a fault if the line goes above +10%; this will help prevent damage to the amplifier if the input is improperly wired.

H) LOW LINE
Similar to "G" above except amplifier U28B will generate a fault with a low line condition. This is not a destructive condition and would merely limit output voltage capability.

I) POWER ON INDICATOR
A green LED that is on whenever ac power is present.

J) OVERDRIVE INDICATOR
A yellow LED that comes on whenever the output voltage is above a preset level, set by front panel trimpot R70. It is adjustable from 0 to rated output voltage and is independent of the over-voltage trip fault. It would normally be set below the fault to indicate approaching a fault condition.

K) READY
An "all is well" green LED that lights to indicate that there are no faults and that the system is operating properly. This light is out when the gain control is in the reset position.

L) FAULT CONDITION INDICATOR
A red LED that lights whenever a fault condition has triggered a fault. If any of the 12 separate faults trip, they will be latched and generate an orderly shutdown procedure for the amplifier. The output will first be driven to zero Volts and held there for a fraction of a second by timer U21, and then the amplifier output will be turned off by driving the gate signal high. If a fault condition has been corrected, it can be reset by rotating the gain control knob fully CCW. THIS INDICATOR IS ALSO ON WHEN THE GAIN CONTROL IS IN RESET, INDICATING THAT THE AMPLIFIER IS GATED OFF.

M) AMPLIFIER ENABLE
A green LED that lights whenever the gain control is advanced.

N) AUXILIARY CONNECTOR J2
All of the 12 faults and various other signals are present on a 34 Pin ribbon cable connector J2 to interface with optional equipment.

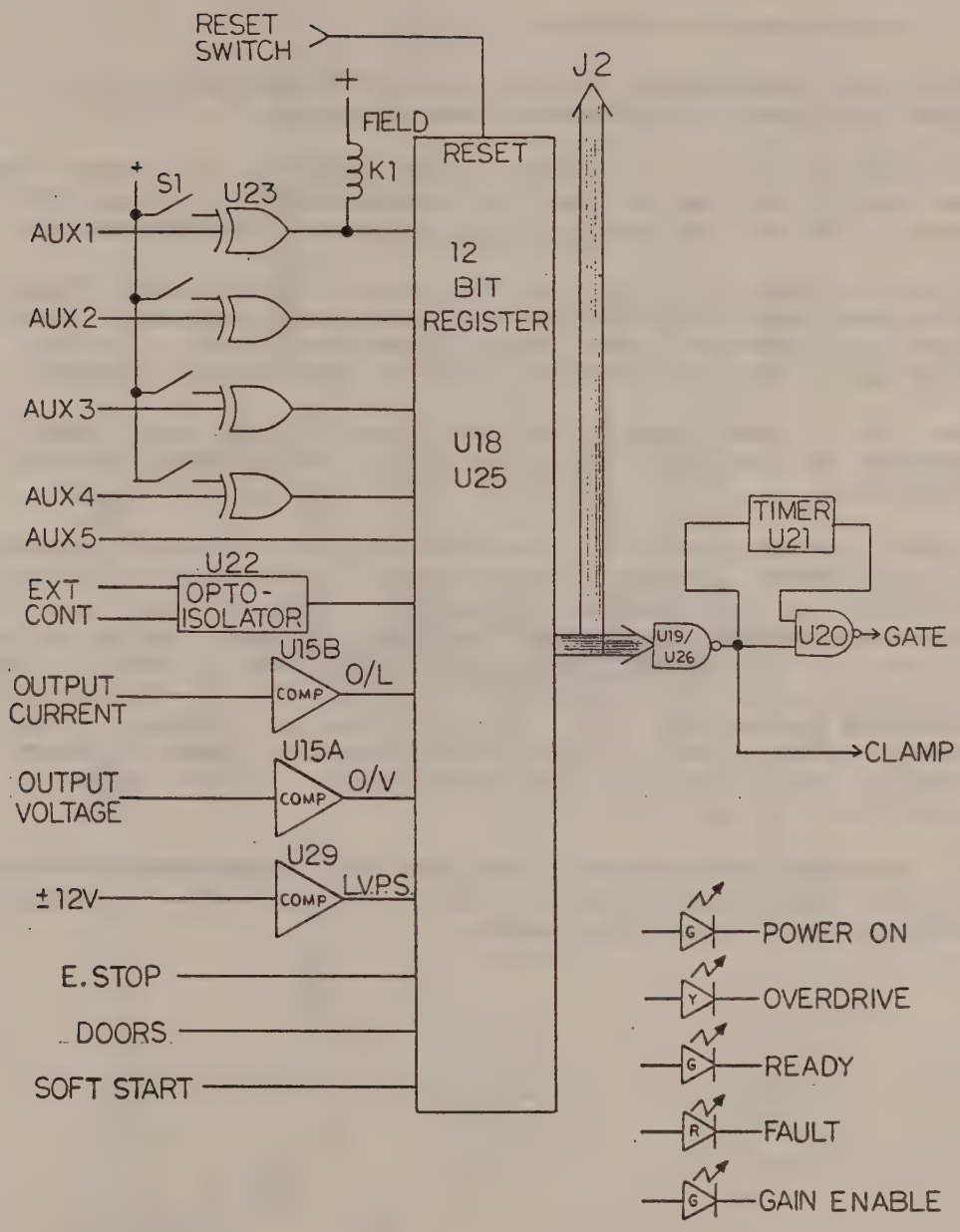



Figure 4-8

LOGIC INTERLOCK BLOCK DIAGRAM

## 4.7 Mainframe Description

The mainframe houses all of the sub-assembles of the amplifier. Refer to Figure 4-9, System Block Diagram.

The bottom section of the cabinet contains the power supply for the amplifier which is an unregulated 3 phase FWB rectified supply from an isolated winding of power transformer 1.

A logic module set provides safety and monitoring functions, and generates the drive signals for the power modules. It is powered from an internal power supply operating off a 115V auxiliary winding on the power transformer in each POWER CABINET.

One to 12 power modules may be installed in each POWER CABINET to provide the required power; they are interchangeable and operate in parallel.

System output current is sensed by a Hall-effect current sensor in each POWER CABINET. The current signal from all installed POWER CABINETS is summed in the system's I/O MODULE and fed to the MODULATOR MODULE to be used to limit maximum output current. This is set for the normalized current from ONE (1) POWER CABINET. The DIP switches in the I/O MODULE must be set for the number of POWER CABINETS installed. Set SW1-2 on for 2 cabinets, SW1-3 on for three cabinets, etc. SW1-1 is not for one POWER CABINET, but rather enables the internal microprocessor to be able to reset the amplifier or not.

All customer connections are located in the rear of SYSTEM CABINET #1 on terminals provided; these consist of: armature, field, cooling unit, and interlocks.

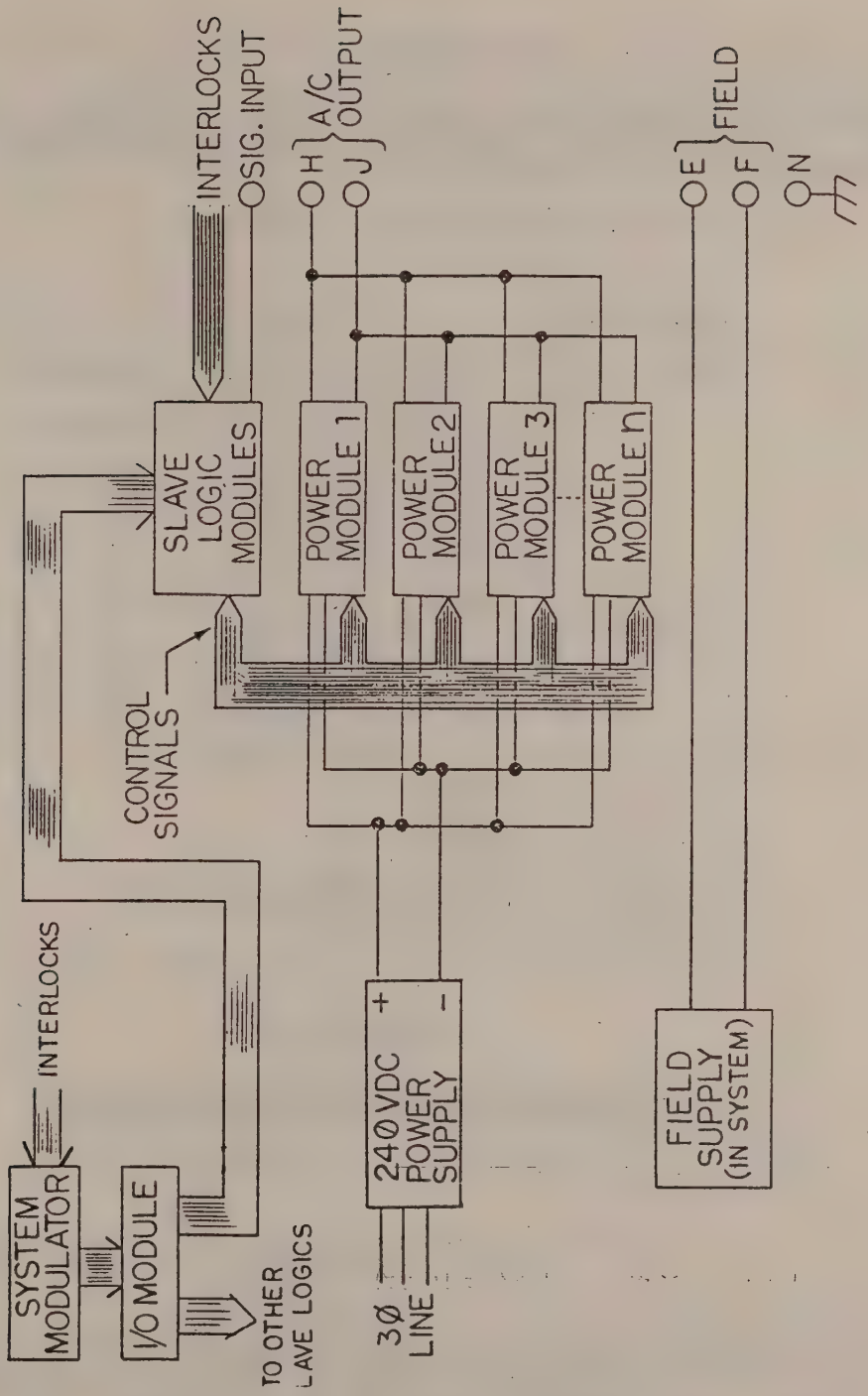



Figure 4-9

SYSTEM BLOCK DIAGRAM

## 4.8 Remote Control Capabilities

The DMA-48/X amplifiers have provision for complete remote control and for monitoring of operating parameters and fault conditions. Control points and functions are:

TB-3 on the A.C distribution chassis

| Terminal | Signal |
|---|---|
| TB3- 1 | Shaker cooling unit interlock |
| 2 | [ ckt. common ] |
| 3 | Shaker overtravel interlock |
| 4 | [ ckt. common ] |
| 5 | Shaker overtemp. interlock |
| 6 | [ ckt. common ] |
| 7 | Field interlock |
| 8 | [ ckt. common ] |
| 9 | Emerg. Stop interlock |
| 10 | [ ckt. common ] |
| 11 | External (isolated) trip input (+) |
| 12 | External (isolated) trip input (-) |
| 13 | Soft Start interlock |
| 14 | [ ckt. common ] |
| 15 | spare |
| 16 | spare |
| 17 | spare |
| 18 | 115 VAC (HI) |
| 19 | 115 VAC (LO) |
| 20 | 115 VAC (LO) |

Table 4-3a

INTERLOCK TERMINAL BLOCK DEFINITION

**CAUTION**

**Both low voltage dc signals and 115 Volt ac power are present on TB3. Do not allow these voltages to become mixed.**

TB-4 on the A.C distribution chassis

| Terminal | Signal |
|---|---|
| TB4- 1 | spare |
| 2 | " |
| 3 | " |
| 4 | " |
| 5 | " |
| 6 | " |
| 7 | Fault indicator, (12V cmos) Lo = Fault |
| 8 | System voltage signal |
| 9 | System current signal |
| 10 | [ ckt. common ] |
| 11 | +12 volts D.C. |
| 12 | -12 volts D.C. |
| 13 | Reset |
| 14 | [ ckt. common ] |
| 15 | Field on command (115 VAC) |
| 16 | Soft Start Enable (115 VAC) |
| 17 | SCU on command (115 VAC) |
| 18 | 115 VAC (HI) |
| 19 | 115 VAC (LO) |
| 20 | 115 VAC (LO) |

Table 4-3b

INTERLOCK TERMINAL BLOCK DEFINITION

CAUTION

Both low voltage dc signals and 115 Volt ac power are present on TB4. Do not allow these voltages to become mixed.

4.8 Remote Control Capabilities ( cont.)

The following connector pin definitions are for the J2 connector on the rear of the SYSTEM CABINET's MODULATOR MODULATOR and uses 12 Volt CMOS logic signals except pins 22 and 24 which are analog signals and pins 1,2,21,23,26-31 which are power supply connections. All are outputs except pins 16, 17 and 20 which are input controls.

This connector is intended for LING designed optional equipment. Please consult LING before using this connector.

| Pin # | Signal | |
|---|---|---|
| J2-1 | Ground [ ckt. common ] | |
| 2 | Ground [ ckt. common ] | |
| 3 | Reset-output monitor | hi = gain enabled |
| 4 | Output overvoltage trip | lo = tripped |
| 5 | Output overload trip | lo = tripped |
| 6 | Aux.#7 trip monitor | lo = tripped |
| 7 | External isolated trip | lo = tripped |
| 8 | SCU trip monitor | lo = tripped |
| 9 | Shaker overtravel trip | lo = tripped |
| 10 | Shaker overtemp monitor | lo = tripped |
| 11 | Field off trip monitor | lo = tripped |
| 12 | Emerg.Stop trip monitor | lo = tripped |
| 13 | Soft Start fault monitor | lo = tripped |
| 14 | Door interlock monitor | lo = tripped |
| 15 | Low voltage power supply | lo = tripped |
| 16 | Remote trip INPUT | lo = trip |
| 17 | Aux #7 trip INPUT | hi = trip |
| 18 | Amplifier fault monitor | hi = fault |
| 19 | Gate drive to power switch modules | lo = gate off |
| 20 | Reset INPUT | lo = reset |
| 21 | Ground [ ckt. common ] | |
| 22 | Output voltage signal | ± 10 Vdc analog |
| 23 | Ground [ ckt. common ] | |
| 24 | Output current signal | ± 10 Vdc analog |
| 25 | Overdrive signal | |
| 26 | + 12 Volts dc | |
| 27 | + 12 Volts dc | |
| 28 | Ground [ ckt. common ] | |
| 29 | Ground [ ckt. common ] | |
| 30 | - 12 Volts dc | |
| 31 | - 12 Volts dc | |
| 32 | 56 kHz square wave clock | |
| 33 | ( spare ) | |
| 34 | ( spare ) | |

Table 4-4

REMOTE CONTROL CONNECTOR - J2

## 4.9 DATA LINK DESCRIPTION

The DMA-48/X incorporates an internal microprocessor to monitor various internal amplifier and external interlock status points. The monitoring microprocessor has a battery backed up real time clock used to apply time 'tags' each status message issued from the amplifier.

The LING DMAX power amplifier's DATA LINK is a simple full duplex RS-232c non-handshaking serial data link operating at 1200 baud. All data transmissions are printible ASCII characters; no control codes are used nor are any special features of any attached terminal, printer or host processor. Its electrical interface requires three wires: transmitted data TX, received data RX, and GROUND.

The processor board contains an 8 bit INTEL 8052 CPU with a built-in floating point BASIC language, 8k of RAM and a 16 k custom programmed EPROM for the control program used in this application.

### 4.9.1 MESSAGE and DATA FORMAT

All commands, data and status messages are transmitted as single ASCII characters or strings of ASCII characters terminated by a carriage return-line feed pair (0Dh 0Ah). These are the only non-visible characters used.

Every status message issued by the amplifier has a time tag attached. For example, an overtravel trip of the shaker during a test would result in the following transmission sequence to the receiving remote device:

```
FAULT AT 09:32:12.
09:32:12 SHAKER OVERTRAVEL
```

The amplifier's internal microprocessor is interrupt driven by the composite internal FAULT signal. The FAULT interrupt routine issues the first message line with the real-time clock time value at the instant that the system trip occurred. Therefore, the trip occurred at 09:32:12.2 ; the time tag with the SHAKER OVERTRAVEL message is simply the time that the message was transmitted.

At the conclusion of the transmission of the complete amplifier/shaker system status, the processor will wait for either of several conditions:

- a 'R'eset attempt command through the DATA LINK

- a hardware reset from either the local or remote control panel to cause all hardware error codes to return to 'normal'

- pressing and holding the 'CLEAR' button on the amplifier's I/O module keypad.

  Note that this alone will not reset the amplifier. Pressing 'CLEAR' will allow the local operator access to the Options sub-menu. Press and hold 'CLEAR' until the display stops scrolling and the cursor remains at line 1 character position 1; release the '#' key and immediately press '*' to have the Options sub-menu presented. Select the 'RESET' option at this time if a system reset is desired. This would most commonly be used to re-start the system and not disturb the gain control setting.

When the microprocessor resumes monitoring, additional messages are issued, such as:

```
FAULTS CLEARED AT 10:23:06
10:23:07 MONITORING
10:23:09 GAIN DOWN
```

### 4.9.2 INTERFACE CONFIGURATION

The monitoring microprocessor is interfaced to external and internal interlock points through an internal three bit address buss. Each address represents a logical function group. The address group functional definitions are:

| ADDRESS | DESCRIPTION |
|---|---|
| 0 | EXTERNAL system interlocks<br>e.g. OVERTRAVEL,OVERTEMP,COOLING UNIT |
| 1 | POWER CABINET #1 interlocks |
| 2 | POWER CABINET #2 interlocks |
| 3 | POWER CABINET #3 interlocks |
| 4 | POWER CABINET #4 interlocks |
| 5 | INTERNAL interlocks & fault detection |
| 6 | INTERNAL status monitoring |
| 7 | Amplifier I.D. number. |

Each address group returns a four bit status code when addressed by the processor. The address and status words are parallel data paths over internal ribbon cables between the I/O module to the slave logic modules in each power cabinet and to the system external interlock adaptor board.

Address group 6 is currently only used to monitor the state of the reset line.

Address group 7 does not return a fault code but rather a four bit identification number in the range 0 to 15. This is provided for multiple amplifier installations so that a central control operator can interrogate several systems and be able to determine with which unit he is currently communicating. The I.D. code is transmitted whenever a 'STATUS' scan is requested or if the I.D. code alone is specifically requested by the remote end of the data link.

## HARDWARE INTERFACE

The monitoring hardware consists of:

- a microprocessor CPU board with EPROM, RAM and a 24 hr. real-time clock
- a local operator's keypad for clock setting and options selection
- a local liquid crystal two line by 40 character display
- a standard RS-232 communication link using DB-25 connectors with the following convention:

  pin 1 - data cable shield
  pin 2 - transmitted data
  pin 3 - received data
  pin 7 - signal common
  (no other pins are used or connected)

The physical interface for the DATA LINK is a female 25 pin DB-25 type 'D-shell' connector located inside the rear door of the main system cabinet. This connector is configured as data communication equipment ( DCE ); the receiving end of the DATA LINK is expected to be configured as data terminal equipment ( DTE ). The electrical pin definitions are:

| AMPLIFIER | | | | REMOTE | |
|---|---|---|---|---|---|
| pin 1 | >>>>> | shield (protective ground) | | | <<<<< |
| pin 2 | transmitted data | TO | pin 3 | received | data |
| pin 3 | received data | TO | pin 2 | transmitted | data |
| pin 7 | data ground | TO | pin 7 | data | ground |

SOFTWARE INTERFACE

All software transmissions are in upper-case ASCII characters. Each status message issued from the amplifier consists of one a one line transmission to the remote CRT, printer or host CPU except for the amplifier's responses to to the 'H'istory request command. The amplifier's response in this case is to print a historical table of the totals of each fault code encountered since the last amplifier power-up. This may be followed by an optional table listing (text) of the meaning of each error or fault code.

### 4.9.3 OPERATING MODES

The monitor processor has several operating modes. In each mode the operator will be given meaningfull prompts by the processor about options availible.

(Note, in all display representations the current value of the real time clock is shown in this manual as hh:mm:ss.t for hours:minutes:seconds.tenths of seconds)

POWER ON RESTART This is the mode entered with each power on cycle ( or after a power fail cycle ). The sign-on messages displayed on the local LCD display and transmitted thru the data link are:

Local display

```
MTI/LING
POWER FAILURE, PRESS '#'
```

Remote display

```
LING ELECTRONICS INC.: DMAX-48 AMPLIFIER MONITOR
(C) 1986, 87 REV.xxx
POWER FAILURE hh:mm:ss
CHECK SYSTEM(S) AND SET CLOCK AS NECESSARY
```

Remote terminal requests are serviced while in this mode.

The power fail mode can only be exited from the local keypad on the DMA-48 amplifier's I/O module. The time displayed by the clock should be checked for correctness if power may have been off long enough to deplete the backup battery.

MONITOR MODE This is the routine the processor enters when there are no remote data link requests pending and all status codes report 'normal' from within the amplifier address groups. While in this mode, the local display will indicate 'MONITORING' at the right of its upper display line. When there is activity requested from the RS-232c remote connection this same upper right display area will indicate 'DATA LINK'. The real-time clock continuously displays the time of day in 24 hour format while the program scans for several conditions:

1. The clock is continuously checked for 'midnight'. When this occurs, a 'day separator line'is transmitted thru the remote data link.

   ==========MIDNIGHT==========

   No indication other than change of time appears on the local display.

2. The local keypad is scanned for keys requesting 'options', 'help', or 'clear'.

   Local display

   OPTIONS '*' INFO '0' CLEAR '#'

The options key '*' allows setting the clock, displaying the current status of the system, resetting the amplifier or tripping the amplifier off line or performing a self test.

Local display

CLOCK=0 SCAN=1 RESET=2 TRIP=3 TEST=4

Selecting the requested option will result in automatic execution or menu prompting as appropriate to accomplish the requested function.

The remote data link is also scanned in the monitor mode for additional requests. These are similar to the locally requestible options with the addition of the ability to request a tabular total fault history of the amplifier, interrogating the amplifier's I.D. code and inserting operator messages into the logged or printed data stream.

Remote display

```
RQST? (C)lock,(H)ISTORY,(I)dentify,(M)sg,(R)ESET,(S)TATUS,(T)RIP
```

This line will be transmitted if any character other than I,H,M,R,S or T is received by the amplifier otherwise the request is serviced immediately. If none of the valid requests are transmitted to the amplifier after receiving the above prompt from the amplifier, a time-out message will be transmitted to the remote display after about 5 seconds.

## FAULT DISPLAY MODE

When the fault line in the amplifier's control logic is tripped, it interrupts the monitoring microprocessor. This stops the display of the clock, 'freezing' the time of the fault on the local display and then displaying a text translation of all non-normal status codes on both the local and remote displays. A typical fault display would appear as:

Local display

```
OFF LINE  hh:mm:ss.t
SHAKER FIELD LOSS
```

Remote display

```
OFF LINE hh:mm:ss
hh:mm:ss  SHAKER FIELD LOSS
```

When the fault is cleared by hardware or software reset, the following message sequence is transmitted:

Remote display

```
FAULT(S) CLEARED AT hh:mm:ss
hh:mm:ss  MONITORING
hh:mm:ss  GAIN DOWN
```

REAL TIME CLOCK

The clock is a 24 hour type clock with battery back up for about 3 weeks. Time is kept and displayed locally to the nearest 0.1 sec. The remote display only shows the nearest second.

### 4.9.4 SYSTEM STATUS MESSAGES

There are three basic areas that the processor monitors. These are EXTERNAL SYSTEM ELEMENTS, POWER CABINET STATUS and INTERNAL INTERLOCKS. The status messages for each EXTERNAL and INTERNAL interlock is unique; however, the messages for each power cabinet are duplicated for each cabinet with the addition of a location tag added to the end of the status message. For example, a SYSTEM OVERCURRENT fault message may well also cause power cabinets #1 and #4 to go OVERCURRENT also. This would result in the following status display.

```
hh:mm:ss SYSTEM OVERCURRENT
hh:mm:ss CURRENT OVERLOAD, POWER CABINET #1
hh:mm:ss CURRENT OVERLOAD, POWER CABINET #4
```

All messages within a group are priority encoded. Only one message per group is displayed even if more than one fault exists. The message with the highest code number is the one displayed. For example if the system experienced an overcurrent at the same time that the shaker overtraveled; only the overcurrent message would be displayed since it has a higher priority than the overtravel situation.

If the higher priority fault clears, then a status change message is transmitted thru the data link and the next highest fault message is displayed locally and on the remote link.

EXTERNAL SYSTEM MESSAGES (address group 0)

The codes listed are the internal binary values as well as the priority level. Codes "0" have the lowest priority progressing to codes "15" which are the highest.

| Code | Status Message |
|---|---|
| 0 | EXTERNAL SYSTEM(S) NORMAL |
| 1 | AUX.#7 TRIP |
| 2 | REMOTE CONTROLLER TRIP |
| 3 | SYSTEM OVER VOLTAGE |

| Code | Status Message (cont.) |
|---|---|
| 4 | FIELD OFF |
| 5 | SOFT START FAULT |
| 6 | COOLING UNIT HI TEMP.OR LOW FLOW |
| 7 | SHAKER: OVER TEMP.OR LOW OIL PRESS. |
| 8 | SHAKER OVERTRAVEL |
| 9 | SYSTEM OVERCURRENT |
| 10 | 12 VOLT SUPPLY(S) |
| 11 | EMERGENY STOP |
| 12 | CABINET DOOR(S) OPEN |
| 13-15 | INTERNAL ERROR ,LM |

POWER CABINET MESSAGES (address groups 1 thru 4)

| Code | Status Message |
|---|---|
| 0 | NORMAL, POWER CABINET #n |
| 1 | 12 VOLT SUPPLY(S), POWER CABINET #n |
| 2 | RAIL VOLTS LOW, POWER CABINET #n |
| 3 | AIR FLOW, POWER CABINET #n |
| 4 | RAIL VOLTS HI, POWER CABINET #n |
| 5 | DRIVE LOGIC ERROR, POWER CABINET #n |
| 6 | POWER SUPPLY OVERTEMP., POWER CABINET #n |
| 7 | CONTROL IDLE, POWER CABINET #n |
| 8 | OVER CURRENT, POWER CABINET #n |
| 9 | OFF LINE, POWER CABINET #n |
| 10-14 | COMMUNICATION ERROR, POWER CABINET #n |
| 15 | NOT INSTALLED, POWER CABINET #n |

INTERNAL STATUS MESSAGES (address group 5)

| Code | Status Message |
|---|---|
| 0 | INTERNAL INT'LOCKS NORMAL |
| 1 | CABLE #4 INT'LOCK |
| 2 | CABLE #3 INT'LOCK |
| 3 | CABLE #2 INT'LOCK |
| 4 | CABLE #1 INT'LOCK |
| 5-7 | INTERNAL ERROR, I/O |
| 8 | AMPLIF./CPU TRIP |
| 9-15 | INTERNAL ERROR, I/O |

INTERNAL STATUS MESSAGES (address group 6)

| Code | Status Message |
|---|---|
| 0 | GAIN DOWN |
| 1 | GAIN ENABLED |

TABULATED LIST OF STATUS MESSAGES

| MESSAGE # | MESSAGE |
|---|---|
| 1 | EXTERNAL SYSTEM(S) NORMAL |
| 2 | AUX.#7 TRIP |
| 3 | REMOTE CONTROLLER TRIP |
| 4 | SYSTEM OVERVOLTAGE |
| 5 | FIELD OFF |
| 6 | SOFT START FAULT |
| 7 | COOLING UNIT HI TEMP.OR LOW FLOW |
| 8 | SHAKER: OVERTEMP.OR LOW OIL FLOW |
| 9 | SHAKER OVERTRAVEL |
| 10 | SYSTEM OVERCURRENT |
| 11 | 12 VOLT SUPPLY(S), SYS. |
| 12 | EMERGENCY STOP |
| 13 | CABINET DOOR(S) OPEN |
| 14 | INTERNAL ERROR, LM |
| 15 | INTERNAL ERROR, LM |
| 16 | INTERNAL ERROR, LM |
| 17 | NORMAL, POWER CABINET #n |
| 18 | 12 VOLT SUPPLY(S), POWER CABINET #n |
| 19 | RAIL VOLTS LOW, POWER CABINET #n |
| 20 | AIR FLOW, POWER CABINET #n |
| 21 | RAIL VOLTS HI, POWER CABINET #n |
| 22 | DRIVE LOGIC ERROR, POWER CABINET #n |
| 23 | POWER SUPPLY OVERTEMP., POWER CABINET #n |
| 24 | CONTROL IDLE, POWER CABINET #n |
| 25 | OVER CURRENT, POWER CABINET #n |
| 26 | OFF LINE, POWER CABINET #n |
| 27 | COMMUNICATION ERROR, POWER CABINET #n |
| 28 | COMMUNICATION ERROR, POWER CABINET #n |
| 29 | COMMUNICATION ERROR, POWER CABINET #n |
| 30 | COMMUNICATION ERROR, POWER CABINET #n |
| 31 | COMMUNICATION ERROR, POWER CABINET #n |
| 32 | NOT INSTALLED, POWER CABINET #n |
| 33 | INTERNAL INT'LOCKS NORMAL |
| 34 | CABLE INT'LOCK #4 |
| 35 | CABLE INT'LOCK #3 |
| 36 | CABLE INT'LOCK #2 |
| 37 | CABLE INT'LOCK #1 |
| 38 | INTERNAL ERROR, I/O |
| 39 | INTERNAL ERROR, I/O |
| 40 | INTERNAL ERROR, I/O |
| 41 | AMPLIF./CPU TRIP |
| 42 | INTERNAL ERROR, I/O |
| 43 | INTERNAL ERROR, I/O |
| 44 | INTERNAL ERROR, I/O |
| 45 | INTERNAL ERROR, I/O |
| 46 | INTERNAL ERROR, I/O |
| 47 | INTERNAL ERROR, I/O |
| 48 | INTERNAL ERROR, I/O |

### 4.9.5 MODEM OPERATION

Operation of the RS-232 DATA LINK has limited range. Depending upon the noise environment, the maximum direct wired range is 50 to 100 feet. When using the optional modem link by connecting a modem at the amplifier and a corresponding modem at the opposite end, this distance may be extended, limited only by the noise level on the telephone or dedicated transmission line.

Several modem configurations are possible using standard telephone modems or direct wire modems.

TELEPHONE MODEMS - If a telephone modem system is to be installed, the modem at the amplifier end must be an auto-answer type since the amplifier is running a general purpose communication protocol and provides for no modem control. The modem at the amplifier must be automatic in operation. More freedom is allowed at the computer or terminal end of the link. This modem and terminal or software combination must be able to initiate a 'call' to the amplifier modem which will answer automatically.

DIRECT MODEMS - A directly connected modem system is hardwired with dedicated wiring between two identical modems. The link is always established and functions as an extended RS-232 data link. LING offers a noise free optiical link modem for direct connections up to 4 kilometers.

The characteristics of the RS-232 link, and therefore the modem connections are 1200 baud, 8 data bits, 1 start bit, 1 stop bit and no parity. No control codes are transmitted. The only non printing ASCII characters are 'carriage return' and 'line feed'. Control codes may be transmitted to the amplifier, but will be ignored.

Data is transmitted by the amplifier on pin 2, received on pin 3, data circuit common is pin 7 and pin 1 is the data cable shield.

### 4.9.6 OPERATION

Operation of the DATA LINK is automatic and is mostly a link to receive ASCII text messages FROM the amplifier. The operator at the far end of the link may initiate single character command requests TO the amplifier to do the following:

| Command Character | Function |
|---|---|
| C | allows the real time clock to be set thru the data link. Format is hhmmss, no punctuation between digits. |
| H | requests the operating 'H'istory of the amplifier/shaker system since the last power down cycle. The amplifier will transmit the number of trips that have occurred, the last system status and a permission request to display the operational history, i.e. the contents of the totalizing array of all the fault error codes. |
| I | requests the amplifier to transmit its preprogrammed internal 'I'dentification number. |
| M | allows a 'dummy' 'M'essage to be transmitted to and remembered by the amplifier, the result is to cause an operator message to be logged into the data stream for inclusion in a printout if a printer is attached or in a disk history file if a computer is attached to the data link. This message is re-transmitted when a `S'tatus command request is serviced. |
| R | 'R'eset the amplifier the same as turning the combined gain/reset hardware control to the 'RESET' position. The amplifier requires a confirmation 'Y' before actually performing the reset operation. |
| S | display the current 'S'tatus of the complete amplifier. |
| T | 'T'rip the amplifier off-line; this requires a confirmation 'Y' as well. |

The amplifier's real-time clock may be set thru the remote data link. Upon power up or after a power fail cycle the local and remote desplays will prompt the operator of the power failure and advise checking the system and/or setting the clock if the power may have been off an extreemly long time. These messages will clear automatically as soon as the processor detects that all the amplifier interlocks have been satisfied. The processor will enter its monitoring mode as soon as the operator or USP-103 option sequences the system up to the full operational point.

CAUTION

Since the amplifier's internal microprocessor has control of the trip and reset lines, it is not advisable to invoke certain functions while the amplifier is delivering power. Setting the clock or using the `test' function from the sub-menu will cause the amplifier's output to momentarily turn off and then back on again.

# SECTION 5
# MAINTENANCE

**WARNING**

High voltages exist in all sections of this equipment. Any electrical servicing should be done by an experienced technician or electrician, especially if there is a need to troubleshoot the system in an energized condition.

GROUNDING - Normally, the signal input (low side), the amplifier output (J terminal) and the logic common are all at case and power ground. The armature and field power supplies are not grounded and must not be inadvertently grounded.

If the 'J' shaker lead is at ground potential, DO NOT connect a grounded scope probe to any of the circuits on any of the POWER MODULES.

Consult schematics prior to connecting instrumentation grounds; when in doubt, isolate line connected equipment with an isolation transformer.

**NOTE**

Use of a grounded scope proble anywhere on the amplifier is not recommended. Always use a line plug isolator.

GENERAL - It is recommended that operational checkouts, cleaning and inspections be performed on a scheduled basis. Initial recommendation is every 250 operating hours; this should be adjusted as necessary to suit particular operating conditions.

## 5.1 Disassembly

The CONTROL MODULES and all POWER MODULES are removed from the front of the unit. However, access to the rear is required to unplug connectors. The POWER SUPPLY is removed from the rear, with access required from the front to disconnect wiring at the transformer and circuit breaker panel.

5.1.1 POWER MODULE Removal -

1. Disconnect power from the unit.
2. Remove the rear power connector and ribbon cable.
3. Remove the front mounting screws.
4. Slide the chassis out the front.
5. Remove the top cover plastic snap clips, slide a flat blade screwdriver between the chassis and cover near each clip and pry up.
6. Reverse this procedure to re-install.

NOTE

All ribbon cables plug-in with the color stripe to the right as viewed from the rear.

SWITCH CARD Removal

1. Remove the power module and cover.
2. Disconnect (2) connectors in the center of the board, (1) ribbon cable and (1) power connector, lift straight out with a slight rocking motion. Protect the fragile pins of the ribbon cable connector after removal.
3. The circuit board is held in place with screws and snap mount plastic connectors, lift the board straight up, avoiding flexing it which may break solder joints.

5.1.2 Control Modules Removal (MODULATOR,I/O,SLAVE LOGIC) -

1. Disconnect power from the unit.
2. Gain access to the rear of the module in question by removing blank panels or other modules.
3. Unplug all ribbon cables and cables.
4. From the front, remove (4) mounting screws, (2) holding each side of the chassis to the cabinet mounting rails.
5. Slide the chassis out the front.
6. Remove all plastic snap clips holding the top cover.
7. Reverse this procedure to re-install.

NOTE

All ribbon cables plug-in with the color stripe to the right as viewed from the rear.

CONTROL/MODULATOR CARD Removal

1. Remove the control module and cover.
2. Remove the front panel gain knob & panel lock nut.
3. Remove (6) screws holding the rear panel to the module chassis.
4. Unplug the power connector at the board.
5. Lift the circuit board off the standoffs.

### 5.1.3 Power Supply Removal

1. Disconnect power from the unit.
2. Remove the (6) screws holding the rear sheet metal power supply cover. DO NOT remove the two (2) lower screws at this time; these hold the power supply chassis in place.
3. Disconnect all external cables (E & F, H & J, interlocks)
4. Remove the lowest 2 or 3 power modules to gain access to the transformer compartment.
5. At the transformer, mark and disconnect all wires from the transformer to the power supply chassis.
6. Remove the (2) lowest chassis retaining screws and slide the power supply out the rear.
7. Reverse this procedure to re-install.

## 5.2 Cleaning, Exterior

Use water based cleaners only on the external finish, controls and indicators. Perform cleaning only with the power off. If excessive amounts of cleaner are sprayed, flushed or spilled into any chassis, do not re-energize the amplifier until the unit has been dried out.

If the exterior fan grills need cleaning, remove the power module; the interior heatsinks will also need cleaning. Do not wash dirt from the grills into the power modules.

## 5.3 Cleaning, Interior ( FANS, GRILLS & HEATSINKS )

Perform cleaning of the power module fans, grills and heatsinks on a scheduled basis to maintain thermal efficiency. Servicing cycles will vary depending upon the installation environment. Clean the air flow path in each power module:

- intake grill on the front of each module
- blades on each vane-axial fan
- heatsink fins and components on each board
- air exit louvers on each power module

Clean with a brush and shop vacuum or compressed air. Use solvents only to clean off accumulated oil films.

Inspect the power supply section, clean as necessary. Use compressed air to blow out the fins of the heatsink that mounts the rectifier diodes. Clean the cooling fan that blows over the rectifier heatsink.

## 5.4 Inspection Of High Current Joints

Cleanliness and tightness of all high current joints is mandatory to prevent oxidation, overheating and FIRES.

Periodically, (within 1000 operating hours after initial installation and yearly thereafter) inspect the following for signs of overheating such as discoloration or melted insulation:

- main input contactor
- power cabinet circuit breaker
- power cabinet power supply transformer
- power supply section:
    - rectifier diodes
    - capacitor filter bank buss bars
    - dc supply to power modules terminal block
- field & armature output terminal blocks
- field & SCU fuses and contactors

## 5.5 Service Log

| Date | Problem | Service Done | By |
|---|---|---|---|
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## 5.6 Spare Parts

Although this equipment is designed for the high reliability of digital electronics certain spare parts are recommended to be kept on hand in order to get maximum amplifier utilization and shorten the mean time to repair (MTTR).

| Service Level | Recommended Quantity | Used on Assy. # | Item Description | LING P/N |
|---|---|---|---|---|
| 1 | 1 | 713137 | Logic Module | 713108 |
| 1 | 1 | 713137 | I/O Module | 712970 |
| 1 | 1 | 713137 | Slave Logic | 712966 |
| 1 | 1 | 713136 | Power Module | 713150 |
| 2 | 1 | 713108 | Modulator | 713112 |
| 2 | 1 | 712970 | Backplane card | 712998 |
| 2 | 1 | 712966 | Slave Card | 712989 |
| 2 | 1 | 712970 & 712966 | Power Supply ( 12 Volts dc ) | 82008-0045 |
| 3 | 2 | 712989 | Transistor | 82451-0026 |
| 3 | 2 | 712989 | Transistor | 82451-0027 |
| 3 | 1 | 712959 | Fan | 80153-0109 |
| 3 | 10 | 713128 | Transistor | PS-11526 |
| 3 | 2 | 713128 | Optocoupler | 82454-0104 |
| 3 | 10 | 713128 | Fuse ( 10 Amp ) | 82145-0199 |
| 3 | 10 | 713128 | Fuse ( 0.25 Amp ) | 82145-0200 |
| 3 | 5 | 713128 | MOV | 82266-061x |
| 3 | 2 | 713128 | Capacitor | 83001-3300k |
| 3 | 1 | 713128 | Diode | 82110-0167 |
| 3 | 2 | 713128 | Capacitor | 83058-0205 |
| 3 | 2 | 713128 | Capacitor | 83058-0442k |

Service level 3 parts are recommended and authorized only for personnel qualified to troubleshoot to the component level. Improper level 3 service may violate FCC Emissions Limits.

No user repairs or replacements are authorized during the warranty period.

**NOTE**

If either the POWER CABINET current sensor (T2) or slave logic module are replaced, the POWER CABINET current limiting MUST be normalized to maintain system calibration (See Section 7.1).

# SECTION 6
# SUPPORT DOCUMENTATION

## 6.1 Drawings

The following LING drawings and parts lists are provided with this manual to assist in operation and servicing.

| DRAWING | TITLE |
|---|---|
| 712543 | Wiring diagram, Power Module |
| 712956 | Schematic, power cabinet |
| 712970 | Slave logic, Assy.& wiring |
| 712972 | Outline and Installation |
| 712996 | Operator's panel, Assy.& schematic |
| 713103 | Wiring diagram, Slave logic |
| 713118 | Block diagram |
| 713119 | Soft start schematic |
| 713122 | Schematic, Control circuits |
| 713144 | Wiring diagram, 300/335 systems |
| 713242 | CPU interconnect |
| 713467 | Snubber Assy. |
| 713612 | Ribbon cabling diagram |
| 713731 | Input isolation Assy. |
| 713792 | Wiring diagram, 335/340 systems |
| 714113 | Schematic, Damper Assembly |

Table 6-1

DOCUMENTATION LISTING

## 6.2 Major Sub-Assemblies

When requesting parts or service on any assembly or sub-assembly, please refer to the list of assemblies:

[ Only electrical assemblies are listed, no sheet metal assemblies are included ]

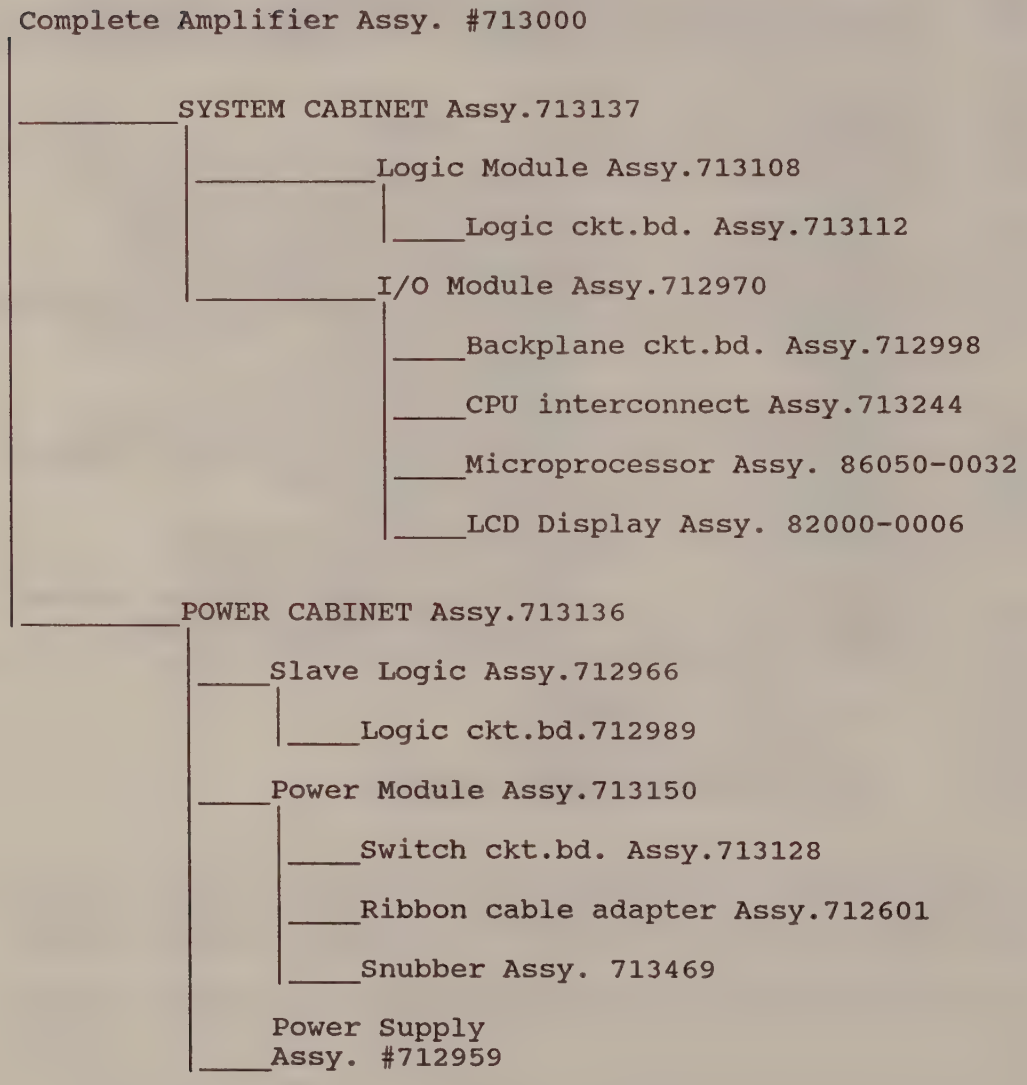



Table 6-2

SUB-ASSEMBLIES CHART

# SECTION 7
# CALIBRATIONS AND ADJUSTMENTS

Test equipment recommended:

- multimeter, FLUKE 8060A or equal
- oscilloscope, TEKTRONIX 223X Series or equal
- clamp-on ammeter, SIMPSON 154-2 or equal
- sine oscillator, H.P. 3310 or equal

## 7.1 Rated Current - Definition

The current rating of the DMA amplifier is 45 rms Amps per power module based on 100% duty cycle and 70°F ambient air available to the power module fans. Higher rms currents are possible until each power module has reached thermal equilibrium. Do not base test spectrum ratings or requirements on "cold" amplifier capabilities. An absolute maximum of 110 Amps peak current ( per module ) can be supplied during random or shock spectra operation.

## 7.2 Current Limit

1. Gain access to the CONTROL/MODULATOR circuit board by either removing the cover with the module still in place or remove the module and re-connect the ribbon cables with the module outside the amplifier enclosure.
2. Turn GAIN control down ( CCW ).
3. Adjust R161 for 0 ± 20 mVolts dc at test point TP12.
4. Apply a 500 Hz 1 Volt peak signal to the input.
5. While monitoring the output current, increase the GAIN control until rated current for the amplifier is achieved. This is 45 rms Amps times the number of POWER MODULES installed.
6. While monitoring the output voltage with a scope, adjust R162 until clipping is observed on the output; then back off slightly.
7. Turn GAIN control down ( CCW )

## 7.3 Output DC Offset

Use of the dc offset control for static load support is not recommended as this offset goes to zero when the amplifier is OFF or tripped. Also power required to support the load subtracts from that available to drive the test.

B. Check the "service" indicators on the front of each POWER MODULE. If any of these are illuminated, the system's operation will be degraded from full performance. The system will still be operable but at lower performance levels. Have any modules in need of service repaired. Refer to Section 8.1.4

C. Verify all voltage checkpoints in Table 8-1.

D. If no conclusive problem is found, change the LOGIC MODULE ( service level 1 ) or alternately change the CONTROL/MODULATOR circuit card ( service level 2 ). See section 5.6 for spare parts and section 8.1.3 for disassembly and replacement.

## 8.1 User Repairs

> Substitution of parts and repairs not not specifically authorized under this heading may cause this amplifier to violate FCC noise limits. For continued FCC compliance, return to LING all modules not defined as user repairable under this section.

### 8.1.1 Fuse Replacement

The most common repair to be encountered will be fuse placement. The chart in Table 8-2 is the complete complement of fuses used throughout the amplifier The fuses pico fuses used on the POWER SWITCH CARD are similar in appearance to 1/4 Watt resistors. The 0.25 Amp are the most fragile; too much heat will open the internal fuse link. Care must be used to remove the fuse from the circuit board without lifting pads or damaging the plated through hole. The SWITCH CARDS are made from 4 oz. copper and will require a minimum soldering iron wattage of 25 Watts.

| Assembly | Designations | Rating | Mfr. P/N |
|---|---|---|---|
| Power Module Switch Card Assy.713128 | F1,3,5,7,9<br>F2,4,6,8,10 | 10 A<br>0.25 A | Littlefuse 275010<br>251.250 |
| Modulator Assy.713112 | F1 | 10 A | Littlefuse 275010 |

Table 8-1

FUSE CHART

8.1.2 SYSTEM LOGIC POWER SUPPLIES

REPLACEMENT

1. Disconnect power and remove the I/O MODULE and cover.
2. Unplug all 12 volt power supply connectors and lift the supply off its standoffs. The 5 volt power supply for the microprocessor must be unsoldered and unbolted from the chassis.
3. Reverse this procedure to install the new assembly.

ADJUSTMENT

The +12 Volts dc and -12 Volts dc supplies are not user adjustable. The +5 volt supply may be user adjusted to +5 volts + or - 5%.

8.1.3 Control/Modulator Card Replacement

1. Follow the instruction of Section 5.1.2 to remove the CONTROL/LOGIC chassis.
2. Remove the front panel of the CONTROL/LOGIC chassis.
3. Unplug the power supply connector from J4 and any options plugged into J6.
4. Remove and replace the circuit card.
5. Perform the current limit calibration for your unit's rated current per Section 7.1.
6. Re-assemble the chassis and install the module.

### 8.1.4 Power Module Repair

REPLACEMENT OF CIRCUIT CARDS

1. Remove the power module SWITCH CARD per Section 5.1.1
2. Disconnect P1, P2 and the two fiber optic cables from the circuit card.
3. Lift the board off its supports and replace.
4. Reverse these procedures to re-install.

REPAIRS TO THE SWITCH CARD

1. If the 'SERVICE' indicator is illuminated on the front of the POWER MODULE, one or more fuses are blown in that respective SWITCH CARD quadrant.
2. Remove the circuit card as outlined above and locate all open picofuses with an ohmmeter. This may be difficult if a power FET transistor is also shorted. Observe ohmmeter readings closely.
3. For each blown fuse there will likely be a failed power FET. Locate these and replace (each are in individual sockets). Also check associated components such as the MOV. Note that no insulating washers are used between the power FETs and the heatsink.
4. Reverse procedures to re-install.

# SECTION 9
# OPTIONS

## 9.1 RCP-105 Remote Control Panel

This option allows the system to control and monitor the operation of the amplifier from a remote location.

Features:
- remote signal injection
- remote gain pot ( the standard local gain control must be left preset at the maximum desired gain ).
- remote meter for amplifier output current.
- remote amplifier fault reset capability.
- remote controls for CONTROL POWER on/off and PA on/off as well as EMERGENCY STOP.

### 9.1.1 USQ-103

This is a programmable controller, interfaced to the amplifier, instrumentation and an external environmental chamber. Its purpose is to help automate the test sequence and gain maximum utilization of the shaker and amplifier. Running the system under USQ-103 operation requires powering up the amplifier, turning the amplifier's gain switch away from the "RESET" position and pressing the RUN/STOP switch once or allowing a remote chamber controller to activate the RUN/STOP input #004. It is not necessary to reset the amplifier, the USQ will do this automatically at the right time.

Interfacing:

| Inputs | Outputs |
|---|---|
| Amp on-line | Amp `trip' Aux.5 |
| Amp `enable' | Amp `reset' |
| run/stop | start DCS-7000 |
| | stop DCS-7000 |
| instrument fault | test complete |
| | Amp blower on |
| | reset instruments |

Programmed Test Sequence:

| Step # | Action |
|---|---|
| 0 | Stop Drive Signal |
| 1 | Wait For `START' |
| 2 | Start SCU |
| 3 | Gain Down Check |
| 4 | Equip. & Instru. Preset |
| 5 | Wait For Interlock |
| 6 | Control Power ON |
| 7 | Delay |
| 8 | P.A. ON |
| 9 | Reset Amplifier |
| 10 | Delay |
| 11 | Reset Equipment |
| 12 | Delay |
| 13 | Start Drive Signal |
| 14 | Wait For `STOP' |
| 15 | Stop Drive Signal |
| 16 | P.A. OFF |
| 17 | Delay |
| 18 | Control Power OFF |
| 19 | Delay For Field Decay |
| 20 | Recyle To Step 0 |

The test sequence is aborted if any of the following conditions are detected:

1. An instrumentation 'fault' occurs in either Step #5 or #6.
2. An amplifier fault occurs in step #6.
3. The gain switch is turned to the 'reset' position during step #6.
4. The auto/manual switch is changed from the `AUTO' position to the 'MANUAL' position.

Please refer to the more detailed documentation supplied with this option for more complete information on interfacing and program capabilities.

## 9.2 Field Expansion of Power Rating

It is possible to expand the power output capability of this amplifier in 5 kVA increments up to 240 kVA.

The DMA-48 amplifier is shipped from the factory with all power harnesses and control ribbon cables necessary for later field upgrade.

The amplifier may be expanded by adding POWER MODULES to an existing POWER CABINET or if the POWER CABINET is full, another POWER CABINET may be added up to the expansion limit of four. The maximum configuration is four cabinets of 12 POWER MODULES each.

Procedure to expand a POWER CABINET:

1. Remove power from the amplifier and allow 5 minutes for the power supply capacitors to bleed down.

2. Remove the blank off panel for the location that is to receive the new power module.

3. Remove any contact protectors on the power connector [P1] and logic connector [P2].

4. Slide the module into place and connect both rear connectors. (red stripes are always to the right)

5. Review section 2.6 for setup and turn-on procedures prior to powering up the amplifier. The POWER CABINET current calibration and trip point must be reset at this time.

Procedure to add a POWER CABINET:

1. Disconnect power to the system

2. Remove two round end covers and one rectangular one covering the opening the new buss bar will run through; save these for installation on the side of the new POWER CABINET.

3. Position the new POWER CABINET and bolt the cabinets together and install the two chase nipples, bushings, and lock nuts in the two round openings between cabinets.

4. Run three new power distribution wires from the lower rear of the SYSTEM CABINET to the power block at the lower rear of the new cabinet.

5. Bolt the new output buss bars in place between cabinets and add a parallel set to the existing cabinet if new cabinet has been bolted to an existing POWER CABINET instead of the SYSTEM CABINET. (this is to handle the double current that will flow through this path). Install the new buss bar insulator sillouette.

6. Gain access to the rear of the system's I/O module and remove the terminator assembly that is shipped in place on the 40 pin connector that is to receive the new ribbon cable to the new POWER CABINET. Plug the new ribbon cable into the correct rear socket on the I/O module and set the DIP switch inside for the new configuration of POWER CABINETS installed. If the new system configuration has two POWER CABINETS, set switch #2 ON. For three POWER CABINETs set switch #3 ON also, leave switch #2 ON. For four POWER CABINETS switches 2,3 & 4 must be ON. This calibrates the system current limit.

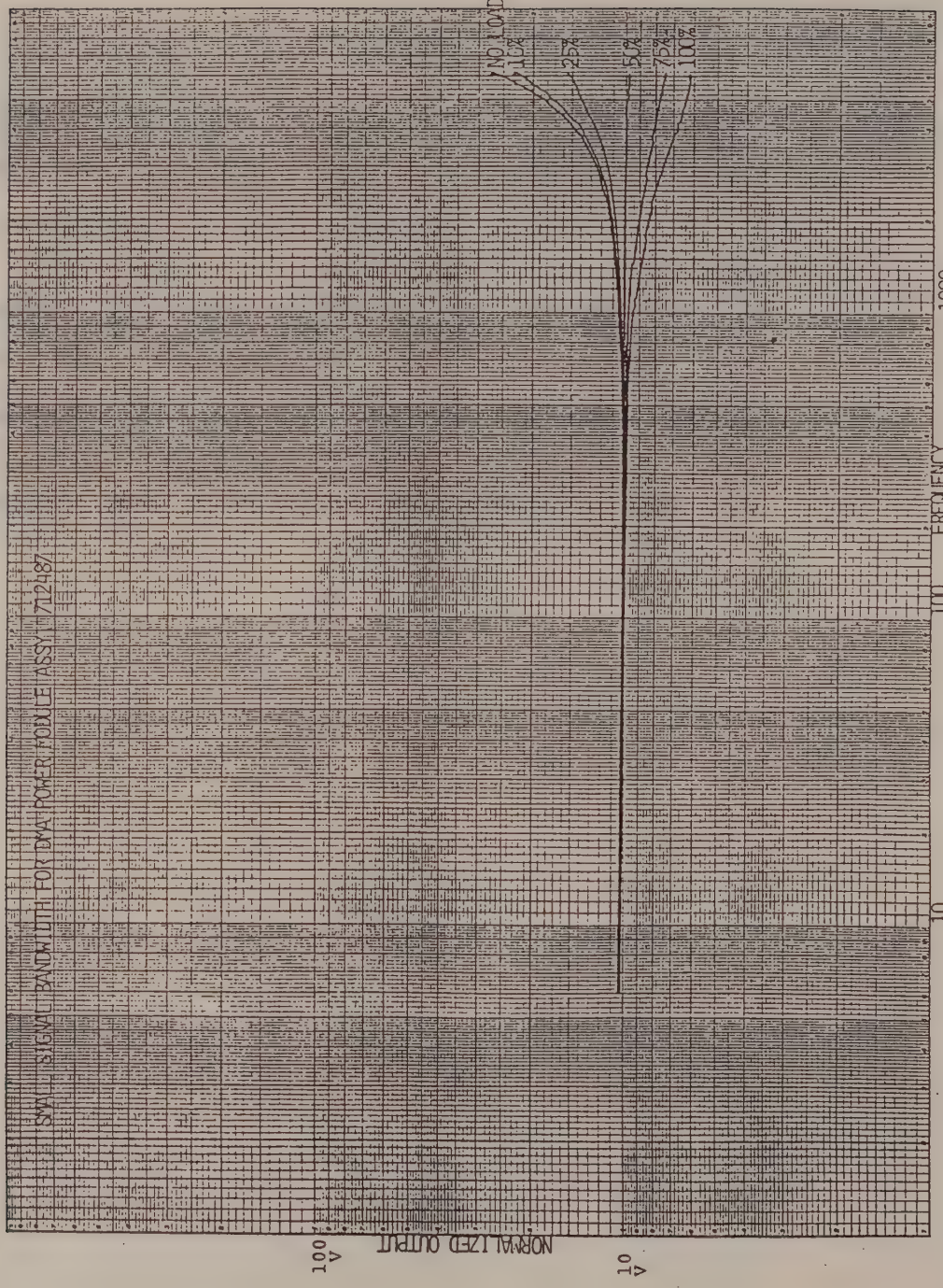
7. Install the 40 pin ribbon cable through the upper rear of the amplifier and plug in to the rear of the new slave logic chassis.

## Appendix A PERFORMANCE CHARTS

Chart #A2 is a plot of the frequency response of the DMA power modules at various load levels. The plots are for the amplifier alone into a resistive load using a swept sine signal source at constant amplitude.

Chart #A3 is the gain/phase plot v.s. frequency for the DMA power module.

Shakers behave as dynamically active loads; at low frequencies V-I phase relationships will be capacitive in nature; at high frequencies the V-I phase relationships will be inductive. Any payloads being tested contribute to the dynamic load impedance. Thus the final system response characteristics will be a composite of the amplifier's response, its output filter and the instantaneous impedance contributed by the shaker and its payload.




FREQUENCY RESPONSE

GAIN/PHASE RESPONSE

NOTES:

LING ELECTRONICS INC. 9/26/89
MODEL DMA-48 SOLID STATE POWER AMPLIFIER

DOCUMENT: INSTRUCTION MANUAL M706722A
ERRATA SHEET No.1

Please make the following additions and/or corrections to LING manual M706722A:

Page x - Add to the list of appendixes:

"Power rating V.S. ambient Temperature.....A4"

in place of:

"Notes:.....A4"

Page 3-3 - Add paragraph after "GAIN CONTROL" description:

"SINE/RANDOM SWITCH This control re-calibrates the system current functions to properly protect the system during both SINE or RANDOM operation. The gain of the current summing amplifier is increased by approximately 20% in the RANDOM position. "

Page 4-1 - Change DISTORTION SPECIFICATION to read:

. . . "0.5% from D.C. to 1500 Hz
0.75% from 1500 Hz to 2000 Hz
1.0% above 2000 Hz to 3000 Hz"

Page 4-2 - Correct "2750 BTU/hr/module" to read "2250 BTU/hr/module"

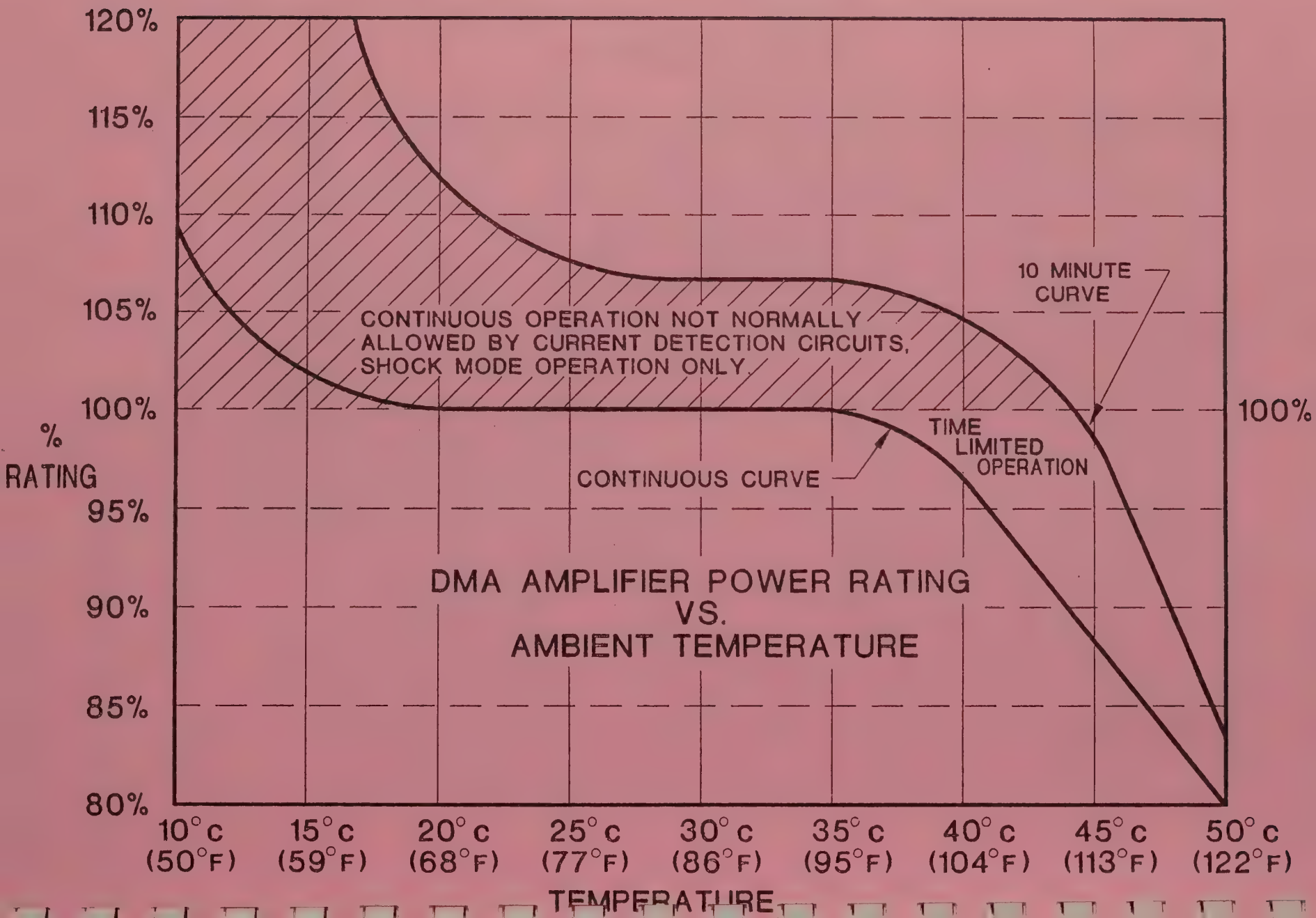
Page 4-17 - Correct Figure 4-8 block labeled "TIMER U21" to read "TIME DELAY"

Page 7-1 - Replace recommended test equipment description list with:

"-Digital battery powered digital true RMS 3 or 4 digit multimeter
-100 MHz dual trace oscilloscope with 10X probes and power line ground isolation plug.
-clamp-on ammeter, 0-1000 amps
-sinewave oscillator, 5-5000 Hz, 0.1% distortion, 600 ohm or less output impedance."

Page A4 - Add new performance chart "Power rating V.S. ambient temperature"

File: C:\work\dmax\docs\ERRATA1.TXT


120%
115%
110%
105%
100%
95%
90%
85%
80%
% RATING
100%
CONTINUOUS OPERATION NOT NORMALLY ALLOWED BY CURRENT DETECTION CIRCUITS, SHOCK MODE OPERATION ONLY.
10 MINUTE CURVE
TIME LIMITED OPERATION
CONTINUOUS CURVE
DMA AMPLIFIER POWER RATING VS. AMBIENT TEMPERATURE
10° c (50° F)
15° c (59° F)
20° c (68° F)
25° c (77° F)
30° c (86° F)
35° c (95° F)
40° c (104° F)
45° c (113° F)
50° c (122° F)
TEMPERATURE

LING ELECTRONICS INC. 27-NOV-89
MODEL DMA-48 SOLID STATE POWER AMPLIFIER

DOCUMENT: INSTRUCTION MANUAL M706722A
ERRATA SHEET No.2

Please make the following additions and/or corrections to LING manual M706722A:

Page ix Add index entry 7.6:

7.6 Power Bay Adjustments & Calibration ..... 7-3

Page 1-1 Change ". . .DCS-7000SR (sine or random spectrum)" to read ". . .DCS-7000SR or DCS-8000 (sine, random or shock signal generation)"

Page 1-2 Change ". . .AGM-4000. . ." to read: ". . .AGM-4000 or AGM-4001. . ."

Page 2-2 Change section 2.3.1 paragraph 2 from: ". . . 2750 BTU/hr/module . . ." to read: ". . . 2250 BTU/hr/module . . ."

Page 2-4 Section 2.4.1 add to paragraph 3: ". . . field contactor. If the amplifier includes the optional power line EMI filter, the power connections must be routed first to the EMI filter and then to the main contactor K6. Depending upon the amplifier size and ordered configuration, this filter may be installed in one of the System Bays or wall mounted as a facilities type filter."

Section 2.4.2 change the last sentence to read: "A cable exit cutout with blank-off plate is pro vided in the lower rear center of this cabinet. Trim the blank-off plate as required for a con toured fit around the installed cable group."

Page 2-7 Move the last paragraph of Section 2.5 to be the last paragraph in Section 2.4.1.

Page 5-6 for the Note box at the bottom of the page: change: ". . . (See section 7.1)" to read: ". . . (See section 7.6)"

Add Section 7.6 as page 7-3 as follows:

## 7.6 POWER BAY ADJUSTMENTS and CALIBRATIONS

Each POWER BAY has internal adjustments to set the current sensor offset, current signal normalization, overcurrent trip point for that bay and adjustments for the front panel meter calibrations. Additionally, starting at circuit board revision D, an adjustment potentiometer is provided for adjusting the peak to RMS current signal weighting factor for amplifier operation with RANDOM drive signals.

Each POWER BAY must be adjusted in turn. Use the "ON LINE/OFF LINE key switch on the front of the Slave Logic module to turn OFF all POWER BAYs except the one being adjusted.

Temporarily gain access to the internal circuit board of the Slave Logic chassis by removing the chassis top cover and gently sliding the module slightly forward and tipping the front edge down as much as possible. Alternately, remove the rear ventilation grille and re-connect the ribbon cables to the circuit board. (There should be enough slack in the internal power harness to allow carefully placing the grille along side of the internal circuit board or power supplies. Use pieces of cardboard as temporary insulators to avoid short circuits as these adjustments will be done with full power applied to the amplifier.

### 7.6.1 AMPLIFIER CURRENT LOAD

Resistive, water cooled power loads are used at the factory to provide a linear, dissipative load for the amplifier. For readjustment in the field the armature coil itself may be used as the current load. Disconnect or turn off the field supply and continue to operate the shaker cooling unit (SCU) during the following procedures.

### 7.6.2 CURRENT SENSOR OFFSET ADJUSTMENT

Connect the D.C. voltmeter to test points TP-1 (signal) and TP-4 (ground), bring the amplifier up to the point of "Drive Active" and set the amplifier's gain control to just off of the RESET (detent) position. Adjust R91 for the closest reading to zero volts D.C. at TP-1.

### 7.6.3 CURRENT SENSOR NORMALIZATION

With all BAYs "OFF" except the one being adjusted, drive the shaker's armature coil at 100-200 Hz to a current level close to the rated current for this bay alone as monitored with an independent clamp on ammeter. Use 45 amps times the number of power modules installed in this bay. Adjust R92 for an A.C. voltage reading at TP-1 of 0.707 Vrms for each 100 amps of output current, e.g. 10 power modules would be driven at 450 amps output and TP-1 set for a reading of 3.18 Vrms.

During this adjustment it may be necessary to adjust R93 to prevent an overcurrent trip from occurring.

### 7.6.4 OVERCURRENT TRIP ADJUSTMENT

Increase the output level from section 7.6.3 an additional 3% by advancing the gain control or increasing the input drive voltage and adjust R93 to just cause a POWER CABINET OVERCURRENT trip for the bay being adjusted.

### 7.6.5 METER ADJUSTMENTS

Adjust the OUTPUT CURRENT METER by driving the bay to 45 amps per module times the number of modules installed and adjusting R95 until the correct amp reading is obtained on the meter. Note that this is not a direct reading meter; the scale is marked in A.C. output amps but the meter movement itself is a 0-1ma D.C. range.

Adjust the D.C. POWER SUPPLY METER using R94 by calibrating against a second, known accuracy D.C. voltmeter connected to the D.C. rails supply of this power bay. The D.C. voltage may be sampled across the +/- terminals of flyback, catch bridge mounted just above the output (H & J) buss mounting blocks.

### 7.6.6 PEAK CURRENT WEIGHTING ADJUSTMENT

Revision X slave logic circuit boards have an additional adjustment potentiometer to give increased weighting to the current peaks that occur in operations using random drive signals. This adjustment is best set empirically by driving the shaker to its full flat spectrum random force rating with the complete amplifier enabled.

Adjust R90 in turn in each power bay while driving the shaker under the conditions listed above until the power bay just trips on overcurrent and then relaxing the adjustment one half turn. This adjustment is based upon an assumption that the random current signal contains three sigma peaks that are representative of the three sigma force peaks that should be present in a true statistically random drive signal. This give increased current protection during random operation.

Page 8-2 change Section 8, II, C to read:
". . . in Table 8-2."

Page 8-3 Add at the start of section 8.1.2:

"The +12 and -12 volt power supplies located in the I/O module supply all power for the logic circuits throughout the amplifier including the Modulator Module and all Slave Logic Modules. The 12 volt supplies located in each Slave Logic Module supply only the power module bias for that particular cabinet. If the microprocessor display indicates: '12 VOLT SUPPLY(S), SYS.' , then there is a problem indicated with one or more of the supplies in the I/O module; adjust, replace or repair as necessary."

Page 8-4  Add Table 8-2 after Section 8.1.4:

The following voltages and waveforms should be found at the following test points on the assemblies indicated.

MODULATOR LOGIC CIRCUIT BOARD, Assy.713112

| Test Point # | Signal type/voltage level |
|---|---|
| TP-1 | 56 kHz clock, 12 volt level |
| TP-2 | 24 v 56 kHz squarewave bias drive |
| TP-3 | +/- 10 volt precision triangle ref. |
| TP-4 | buffered drive signal |
| TP-5 | buffered A.C. feedback |
| TP-6 | modulation from error amplifier |
| TP-7 | control gate, lo=fault, hi=enabled |
| TP-8 | P.W.M. quadrant DRIVE #2 |
| TP-9 | " " DRIVE #1 |
| TP-10 | " " DRIVE #3 |
| TP-11 | " " DRIVE #4 |
| TP-12 | +12 volts |
| TP-13 | as TP-2 except 180 deg. out of phase |
| TP-14 | adjusted output current level signal |
| TP-15 | signal clamp |
| TP-16 | -12 volts |
| TP-17 | ground (circuit common) |
| TP-18 | ground (circuit common)* |
| TP-17 | +12 volts |

I/O MODULE, Backplane Assy.712998

| Test Point # | Signal type/voltage level |
|---|---|
| TP-1 | +12 volts |
| TP-2 | -12 volts |
| TP-3 | gate signal, Power Cabinet #1 |
| TP-4 | " " Power Cabinet #2 |
| TP-5 | " " Power Cabinet #3 |
| TP-6 | " " Power Cabinet #4 |
| TP-7 | output feedback (+) |
| TP-8 | " " (-) |
| TP-9 | 24 V bias supply squarewave drive |
| TP-10 | " " " " " |
| TP-11 | P.W.M. Drive #4 |
| TP-12 | " Drive #3 |
| TP-13 | " Drive #2 |
| TP-14 | " Drive #1 |
| TP-15 | ground (circuit common) |
| TP-16 | buffered, summed system current signal |
| TP-17 | multiplexed V/I signal as selected by microprocessor |

| | |
|---|---|
| TP-18 | combined system fault signal,hi=fault |
| TP-19 | microprocessor address line A0 |
| TP-20 | " " " A1 |
| TP-21 | " " " A2 |
| TP-22 | multiplexed fault code bit Q3 |
| TP-23 | " " " Q2 |
| TP-24 | " " " Q1 |
| TP-25 | " " " Q0 |
| TP-26 | ground (circuit common) |
| TP-27 | ground (circuit common) |
| TP-28 | +12 volts |

SLAVE LOGIC CIRCUIT BOARD Assy.712989

| Test Point # | Signal type/voltage level |
|---|---|
| TP-1 | normalized current signal (A.C.) |
| TP-2 | power bay FAULT, hi=fault, lo=ready |
| TP-3 | +12 volts from the local bias supplies |
| TP-4 | ground (circuit common) |
| TP-5 | -12 volts from the local bias supplies |
| TP-6 | power module quadrant DRIVE #1 |
| TP-7 | " " " DRIVE #2 |
| TP-8 | " " " DRIVE #3 |
| TP-9 | " " " DRIVE #4 |
| | (DRIVES 1-4 are P.W.M. modulated square waves. 0 volts out=50% duty cycle=0% modulation.) |
| TP-11 | constant 24 V pk-pk square wave present whenever that bay is energized. |
| TP-12 | (as TP-11 except 180 deg. out of phase) |
| TP-13 | ground (circuit common) |
| TP-14 | fault code BIT 0 |
| TP-15 | " " BIT 1 |
| TP-16 | " " BIT 2 |
| TP-17 | " " BIT 3 |
| TP-18 | ground (circuit common) |
| TP-19 | +12 volt logic supply from I/O module |
| TP-20 | ground (circuit common) |
| TP-21 | " " " |
| TP-22 | " " " |
| TP-23 | " " " |
| TP-24 | " " " |
| TP-25 | -12 volt logic supply from I/O module |
| TP-26 | D.C. proportional to current (metering) |
| TP-27 | reset, +12=reset |

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LING ELECTRONICS INC. 15-JAN-90
MODEL DMA-48 SOLID STATE POWER AMPLIFIER

DOCUMENT: INSTRUCTION MANUAL M706722A
ERRATA SHEET No.3

Please make the following additions and/or corrections to LING manual M706722A:

Page vii ADD section listion:

"1.3 Standards .....1-4"

Page x ADD to the list of appendixes:

"Psychrometric chart for relative humidity.....A-5"

Page 1-4 ADD section 1-3 to read:

1-3 STANDARDS

The DMA-48 amplifier is built to conform to the following standards and regulations.

DOCUMENT: NFPA 70-1985

National Electrical Code as adopted by the National Fire Protection Association.

DOCUMENT: CFR Title 29 Part 1910.303, 1910.304, 1910.305

Code of Federal Regulations, Occupational Safety and Health Administration (OSHA)

DOCUMENT: UL 1244

Underwriters Laboratories, Standard for Safety, Electrical and Electronic Measuring and Testing Equipment

DOCUMENT: UL 1262

Underwriters Laboratories, Standard for Safety, Laboratory Equipment

Page 4-1 ADD "TEMPERATURE - Full power to 40 C, derate at 2% per degree C above 40 C to 55 C.

ADD "HUMIDITY - 0 to 80% with wet bulb temperature not to exceed 27 degrees Centegrade. The amplifier should be oper ated under conditions of relative humidity levels less than those which would produce internal condensation if the ampli fier's temperature is lov er than that of the intake air as read on a standerd psychrometric chart. (ap pendix A-5)

Page 2-2 in section 2.3.1, last paragraph ADD:
"In tropical or marine locations run the amplifier cooling fans for five minutes prior to driving the amplifier to equalize the internal temperature with the external temperature. Refer to section 4.1 on HUMIDITY and the psychrometric dew point chart of appendix A5.

"For operation in ambient temperatures above 40 de grees centagrade the amplifier's power rating must be de-rated by 2% per degree rise above 40 C. Since the shaker's force rating performance is related to the square of the amplifier's power, this will cause a corresponding de-rating of the system's force rating the fraction:

$$\sqrt{\text{FORCE}} = \frac{100\% - (\text{value from chart A4})}{100}$$

I.E. operation at 45 C will be at 90% of the ampli fier's current rating and 31% reduction of the sys tem force rating to 69%.

Page 3-6 ADD after section 3.2 paragraph 1: "Allow the cabi net fans to run for five minutes to equalize inter nal temperatures prior to driving the amplifier."

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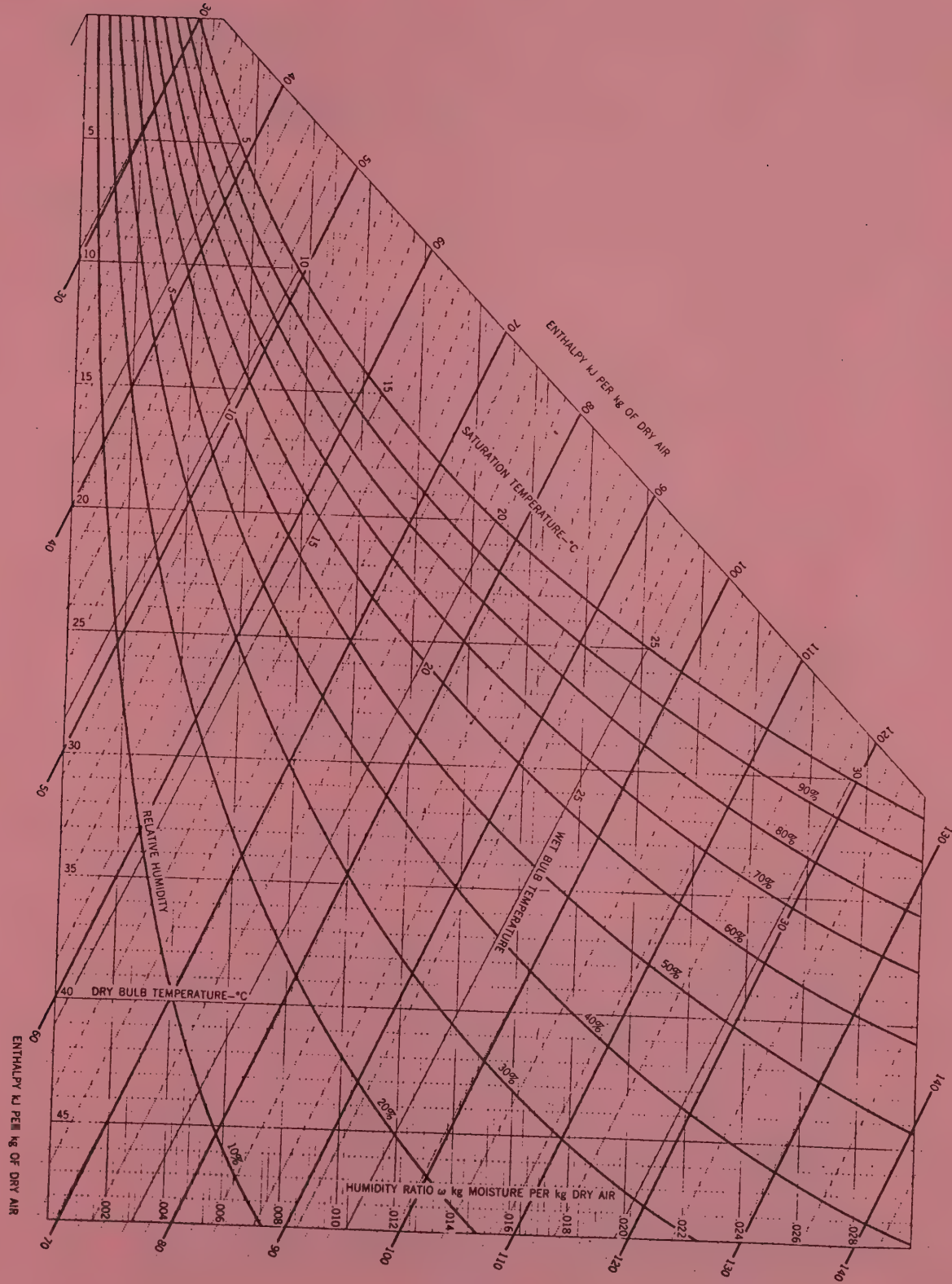


APPENDIX A-5. PSYCHROMETRIC CHART

LING ELECTRONICS INC. 16-July-90
MODEL DMA-48 SOLID STATE POWER AMPLIFIER

DOCUMENT: INSTRUCTION MANUAL M706722A
ERRATA SHEET No.4

Please make the following additions and/or corrections to LING manual M706722A:

Page 1-3 ADD to Section 1-3

"DOCUMENT: ISO 5344-1980 (Int'national)

Electrodynamic Test Equipment for Generating Vibration

"DOCUMENT: BS 6140:Part 1:1980 ( U.K.)

Test Equipment for Generating Vibration

Page 3-6 ADD to section 3.2 paragraph 3:

"CAUTION - whenever the amplifier's gain control is advanced off of the reset position, DO NOT plug or unplug any drive signal cables or turn the power on or off to the vibration control system. Unpredictable results may occur that could be hazardous to personnel or the equipment."

Page 8-1 ADD after the first paragraph:

"If output modules are being damaged in service, perform the following check:

With the amplifier powered up but the gain control in the "RESET" position, check the D.C. power supply voltages between chassis and each D.C. rail supply. (located behind the capacitor bank power supply cover, also accessible on BR-1 + & - terminals) This must read half of the voltage read across the capacitor bank itself. If not, DO NOT drive the amplifier. Turn off the power and wait one minute then disconnect all output modules at their round power connector. Repower the amplifier and re-check the D.C. reading to chassis. If the readings are now balanced, the problem is within one of the output modules (See Section 8.2.2 on 'Finding Bad Output Modules'), otherwise there is a problem within the mainframe power supply section.

Wait at least 5 minutes for the power supply to discharge before reconnecting the output modules.

Page 8-4 ADD Section 8.2.2:

"8.2.2 Finding Bad Output Modules

An output module may go bad and cause problems with system operation. It is best to find the bad module and disconnect it from the amplifier. In the DMA amplifier, all output modules operate in parallel driven in synchronism by the pulse width modulated drive signals from the control logic module.

Symptoms of a bad module may be:

- excessive distortion on the output
- "ringing" present on the output in the 8-11 kHz region
- "service" indicators illuminating frequently
- internal buzzing sounds

To find a suspected bad output module, perform the following steps:

1. turn off power to the amplifier.
2. disconnect the round black plastic connector at the center rear of the suspect module.
3. re-power the amplifier and drive the system to the point where the abnormal behavior occurs.
4. if the problem is now gone, you have found the bad module. You may call LING for service advice or, if out of warranty, have service performed by your qualified technician.
5. if the problem is still present, turn power off to the amplifier again and WAIT 5 MINUTES for the power supply to discharge.

   CAUTION, A SEVERE ARC WILL OCCUR IF THE POWER CONNECTOR IS RECONNECTED WITHOUT WAITING FOR THE SUPPLY TO DISCHARGE!

6. reconnect the black plastic connector on the module and move to another module to repeat the above steps.

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MP MASTER
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